"NATIONAL" MODERN WELDED PIPE

"NATIONAL" MODERN WELDED PIPE

FROM IRON ORE
TO FINISHED
PRODUCT

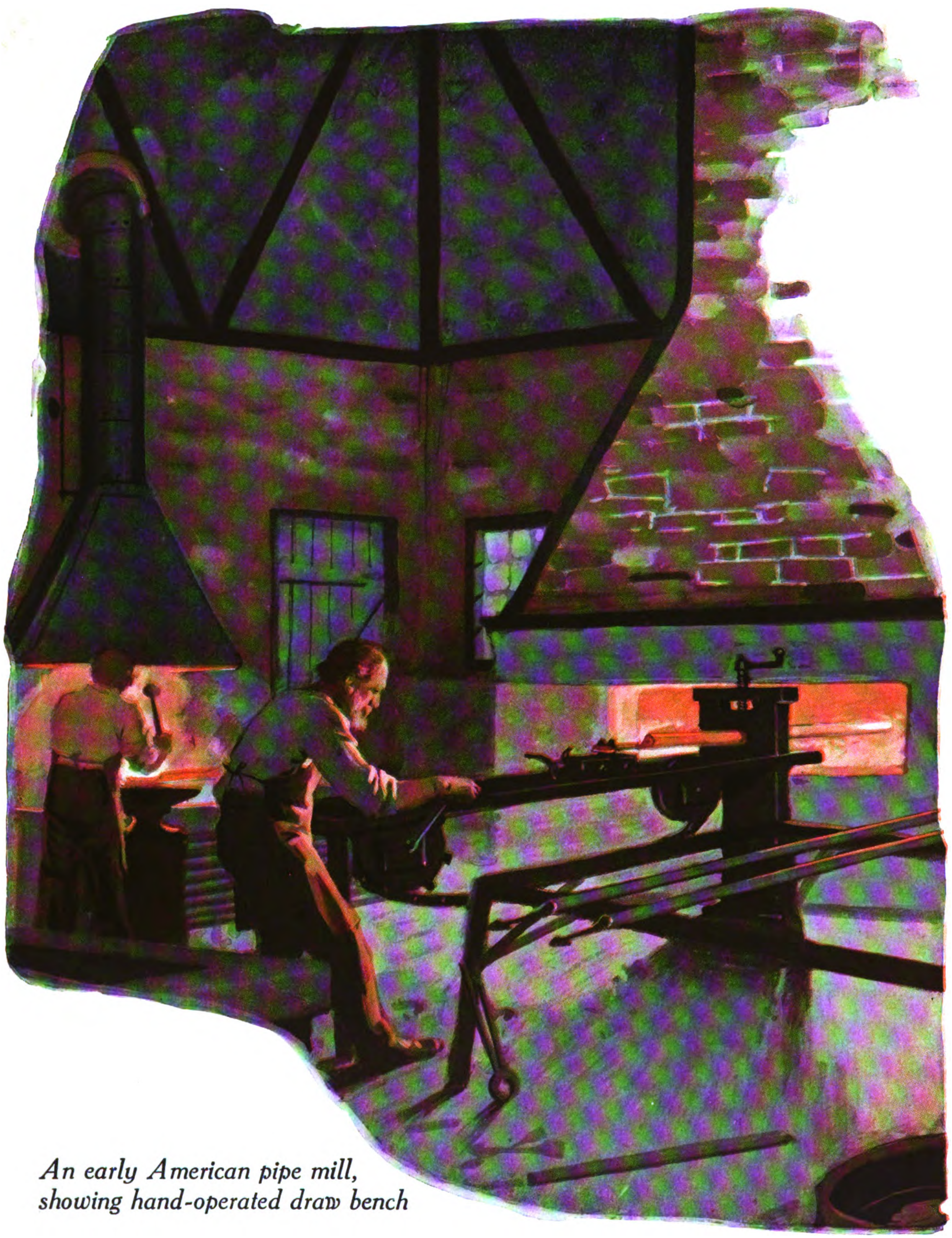
NATIONAL TUBE COMPANY
PITTSBURGH · PENNSYLVANIA

FOREWORD

ALTHOUGH NATIONAL TUBE COMPANY has published a number of bulletins, booklets and other literature dealing with specific problems connected with the use of wrought pipe and allied tubular products, each one of these publications has been confined to a particular field, or to some special phase of the pipe or tube industry, and no attempt has been made in any of them to cover the basic subject of welded pipe manufacture, from ore to finished product.

The manufacture of welded tubular products is an interesting subject, particularly to those who have occasion to use pipe and who may not find it practicable to make a personal visit to a pipe or tube mill. It is the purpose of this booklet to give a comprehensive view of the industry from the prospecting for the ore to the shipping of the finished product. While the description of manufacture is given in non-technical style for the benefit of the layman, it has, nevertheless, been compiled with the utmost care as to accurate mill practice and will be found to cover practically all operations and processes of any importance.

Numerous illustrations and diagrams have been used in this booklet to supplement the text matter and to assist in visualizing the actual scenes as they appear in practice. The different subjects have been placed under separate heads to facilitate reference, and all subjects will be found in their natural order of sequence.



An early American pipe mill, showing hand-operated draw bench

A Short History of Pipe and Early Methods of Manufacturing

IN the early history of man's endeavor to solve the difficulties of mere existence, some sort of tube for the conveyance of fluids must have been employed. Probably the "bamboo", which in tropical countries grows to five or six inches in diameter at the base, was used. It is today frequently used by coolie gardeners for conveying water along the surface of the ground for short distances. The next step was a "pottery" tube, and these have been found in the Egyptian, Aztec and other prehistoric remains, which are brought to light by the excavations of archaeologists.

Primitive Tubes

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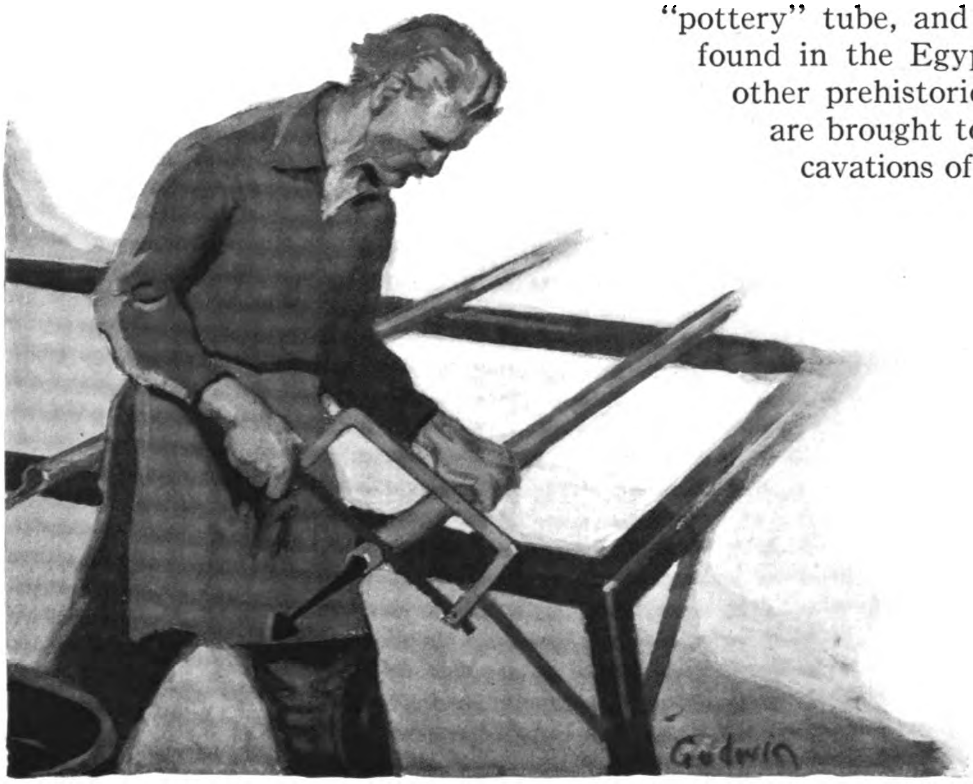


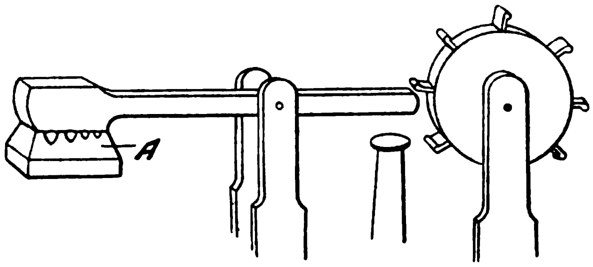


Fig. 1

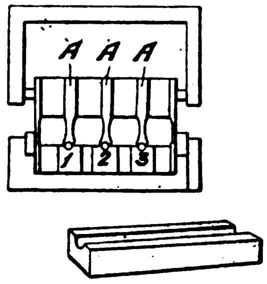


Fig. 2

There is ample evidence that lead tubes were largely used in Grecian and Roman civilization. In many museums lead pipe and bronze water faucets (closely resembling the modern faucet) are shown which were recovered from the ruins of Pompeii and Herculaneum, and from other buried cities.

Pliny, whose writings cover about the last three-quarters of the first century, A. D., states that "in order to raise water up to an eminence leaden pipe must be employed."

First Iron Tubes

Probably the first imperative need for iron tubes was for the manufacture of gun barrels. After the invention of gunpowder, the first cannons were made of bronze, and early Spanish cannons are wonderful examples of metal-working skill in ornamentation.

But bronze was too expensive a material for gun barrels, and the need for cheaper material brought out the earliest application of wrought iron for tubes.

First Methods of Welding Tubes

In the early history of wrought iron tubes, the only known method of manufacture consisted of bending an iron plate or strip to form a "skelp", and the edges were welded together piecemeal by a smith hammering the red hot metal over a rod or mandrel—a rather expensive and tedious process.

In 1812 an Englishman named Osborn patented machinery for "welding and making barrels of firearms and other cylindrical articles."

Referring to Figure 1, above, the skelp is raised to a welding heat in an open or closed fire and, after the mandrel has been inserted, is then placed in the swage, or anvil, A, and welded by the action of the tilt hammer.

Referring to Figure 2, the inventor states: "I take a skelp and place it in any of the beds 1, 2, 3, according to the part required to be welded, and which welding is effected by the swage segments A performing half a revolution, the manner of which is explained by the profile B" (Fig. 3, page 9).

This is believed to have been the earliest form of machinery for welding iron tubes. But as may readily be seen, the process was not very rapid, and in the next two or three years a new necessity arose for iron tubes in quantities.

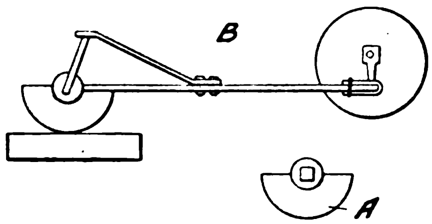


Fig. 3

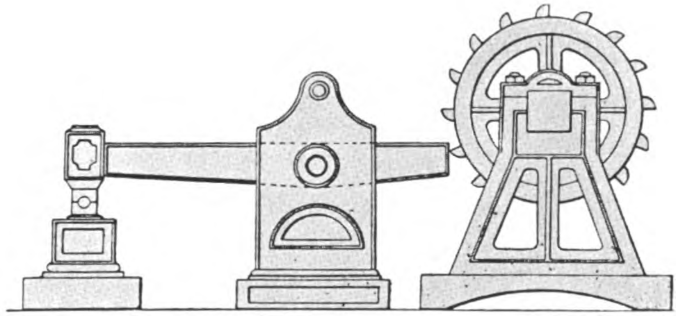


Fig. 4

About the time of Osborn's invention for tube-welding machinery, another Englishman was perfecting his process of making coal gas for lighting purposes.

Gas Tubes from Gun Barrels

Iron tubes (gas-tight) for this purpose were essential, and the inventor of gas lighting, Murdoch, first collected and used old gun barrels, of which there was an abundant supply at the close of the various European wars, screwing barrels together into a continuous tube to convey the gas.

This primitive method of piping, by which gas was conveyed about the gloomy streets of London, was perhaps in keeping with the scope and development of gas lighting at that time.

The extension of gas lighting, however, was very rapid, and the necessity for production of iron tubes with greater facility and less cost became apparent.

First Butt-welding Process

The inventors were equal to the occasion, as they generally seem to be. In 1824 James Russell filed a specification for "an improvement in the manufacture of tubes for gas and other purposes." This apparatus is shown in Figures 4, 5 and 6, pages 9 and 10.

Figure 4 represents the apparatus for welding. The tilt hammer is retained (see Figure 1, page 8), but the weld can be formed either with or without a mandrel, and the edges are butted against each other, and not overlapped as in gun barrel welding.

The tube is finished between rolls in conjunction with a mandrel, as shown in Figures 5 and 6, page 10.

Perfecting Butt-welding Process

The great importance of this specification was in the discovery that a sufficiently sound weld can be made by pressing, or rather forcing, the abutting edges of the tube against each other.

The next year, 1825, Cornelius Whitehouse invented a process of butt-welding wrought iron tubes, which forms the basis of the present day "bell" process.

The introduction of the Whitehouse invention at once not only greatly reduced the price of iron tubes, but supplied a far superior article.

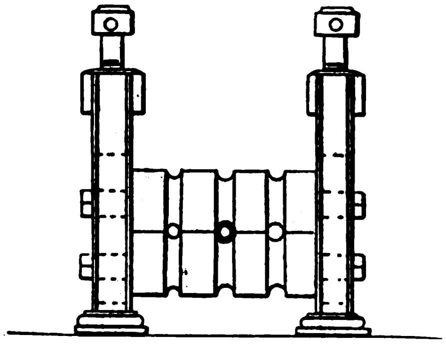


Fig. 5

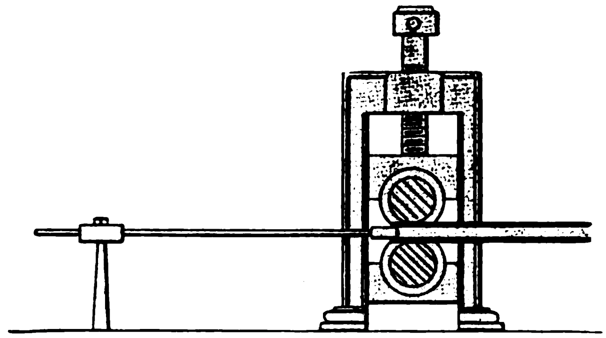


Fig. 6

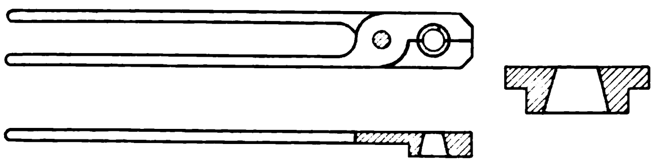


Fig. 7

Early welding rolls (Figs. 5 and 6)

Combination of tongs and welding-die used in very early pipe welding operations (Fig. 7)

Wheeled tongs or buggy (Fig. 8) sometimes used in connection with early type of die and draw bench (Figs. 9 and 10)

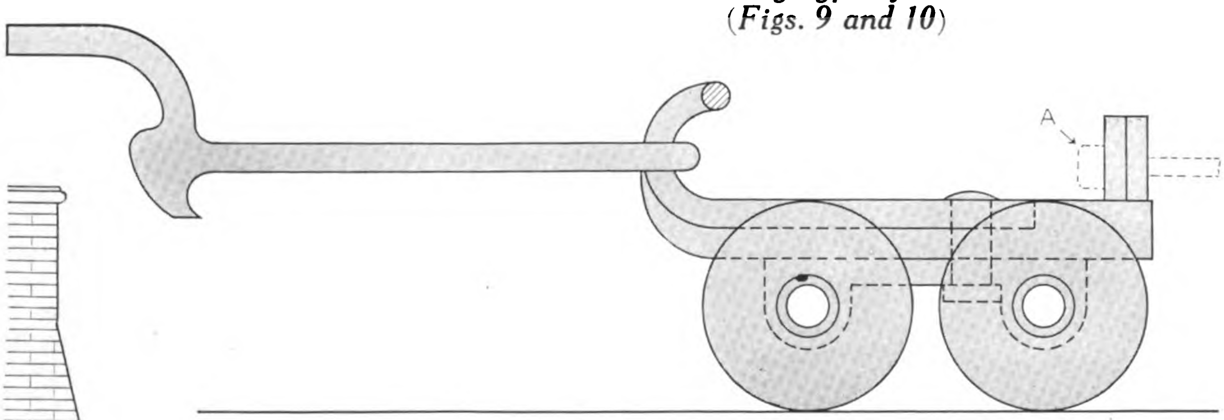


Fig. 8

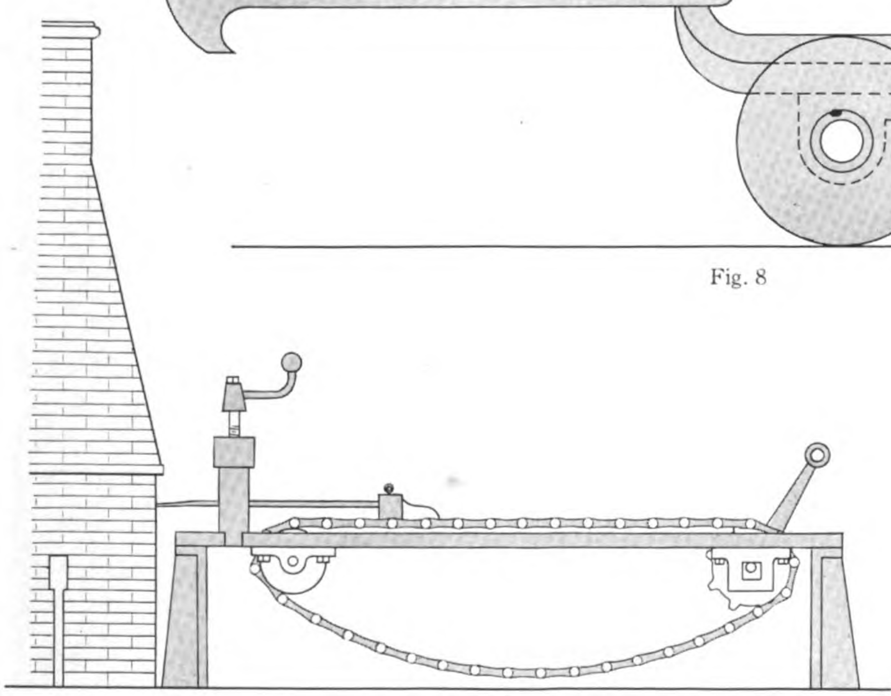


Fig. 9

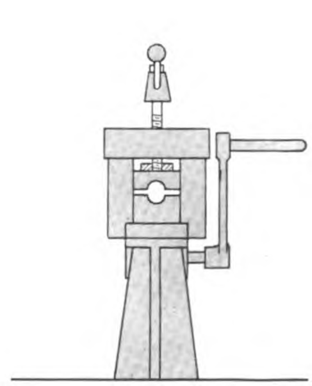


Fig. 10

First American Pipe Furnace

IN America, as in Europe, there was a fast growing demand for better tubular products. The successful introduction of artificial gas for lighting purposes, the need for boiler tubes, an ever-increasing demand for durable tubes for water supply systems, and numerous other conditions, necessitated the establishment of domestic industries for manufacturing pipe.

First American Pipe Furnace

Probably the first furnace for making butt-weld pipe in the United States was built between 1830 and 1834, by the firm of Morris, Tasker & Morris in the cellar of a shop at Third and Walnut streets, Philadelphia, the welder being William Griffiths, who had learned and followed his trade in England.

In 1836 this firm erected a mill and a machine shop on the block of ground now bounded by Fourth, Fifth, Morris and Tasker streets. This was known as the Pascal Iron Works. In 1849 a building was erected, having space for nine welding furnaces, together with the necessary machinery.

Growth of Pipe Industry in East

On July 1, 1847, James J. Walworth of the firm of Walworth and Mason, of Massachusetts, sailed for England to investigate the tube-making industry in that country. From July 17 to July 22, 1847, he visited the Russells at Wednesbury, Staffordshire, and at Handsworth. After he had inspected their works he sailed for home Sept. 4, bringing with him plans for the erection of a tube mill.

The following year the Wanalancet Tube Company was formed, and on September 18, 1848, Messrs. Ridley and Fellows, from Jas. Russell and Sons, England, came to assist in the erection of the mill.

On November 3, 1849, the first tubes and pipe were made, and in that year they manufactured one-inch pipe, three-fourths-inch pipe, and three-inch flues.

This works continued in operation until 1853.

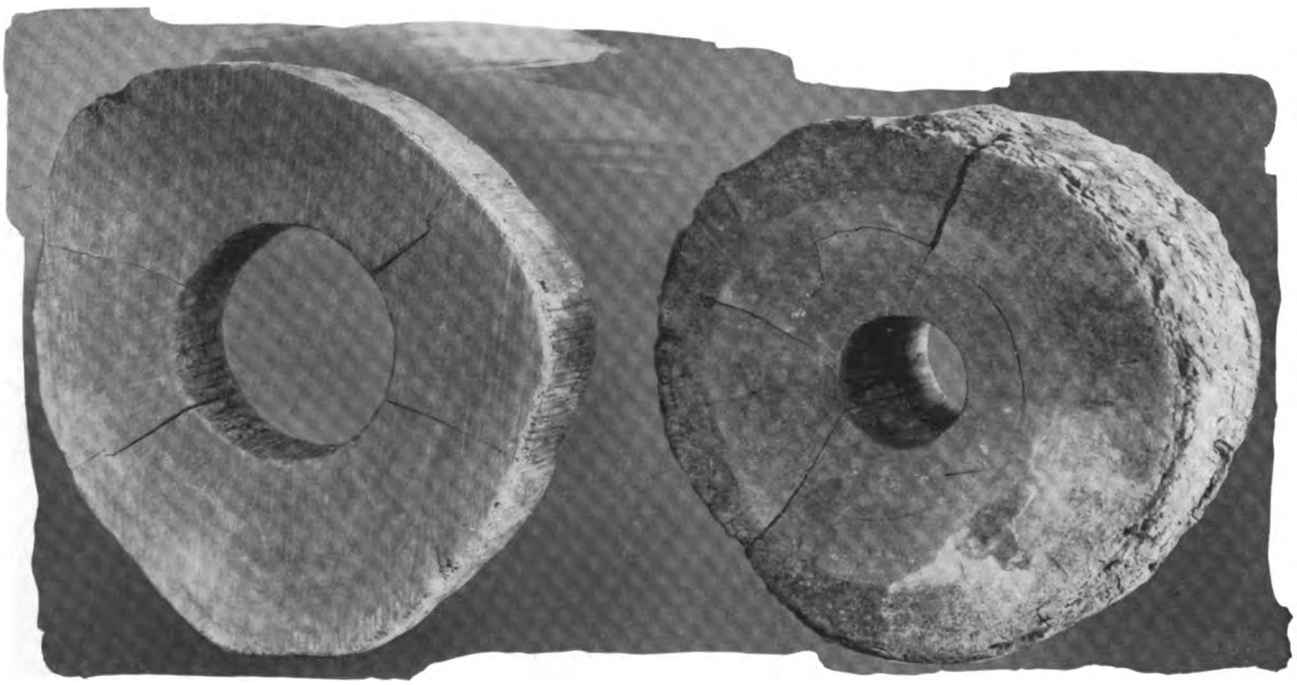
Among the other early pipe mills established in addition to the two named above were: Griffith Bros., Philadelphia, Pa.; Seyfert, McManus & Co., Reading, Pa.; Allison & Co., Philadelphia, Pa.; Girard Tube Co., Philadelphia, Pa.

Other Early Pipe Furnaces

There were also small mills at Exeter, N. H., Taunton, Brooklyn, N. Y., Jersey City, N. J., Conshohocken, Pa., and two near Boston, Mass.

West of the Alleghenies, several mills for manufacturing pipe were established about 1860 and 1864—and one at Chicago in 1865.

Later, in 1868, the Flagler Company established a pipe mill in East Boston. A more detailed history of the progress and growth of this company, which eventually became National Tube Company, is given in the chapter immediately following. In this chapter are also given the circumstances attendant upon the manufacture of the first wrought pipe made from steel. It should be interesting to consider the status of steel pipe as first made in comparison with its present development—this material now representing over 90% of all wrought pipe used; and with this tremendous increase in tonnage has come a corresponding increase in the uses of wrought pipe. Primarily used as a conveyor of water, gas, oil, steam and air, its present uses can scarcely be enumerated, and its various applications would afford interesting study to those who ordinarily have only a casual interest in pipe.



An early method of conveying water—the bored log

History of National Tube Company

THE old adage, "Big trees from little acorns grow", has been amply exemplified in the growth of NATIONAL TUBE COMPANY.

Beginning in Boston, Mass., in 1865, two brothers, John H. and Harvey K. Flagler, under the firm name of Flagler & Company, sold various lines of iron merchandise. Among these products were boiler tubes manufactured by Morris, Tasker & Company, a Philadelphia firm. Subsequently, owing to a disagreement, the Philadelphia firm severed the connection, and the Flagler Company, having created a considerable demand for tubular products, determined to enter the manufacturing field and supply the demands with its own products.

Early History

Accordingly, in 1868 they established in East Boston a small plant covering a space of about 20 x 125 feet.

First Pipe Mill

Though the Company's organization was small, it was not lacking in energy and progressiveness. A systematic study of the needs of the comparatively new and rapidly increasing oil business enabled them in a short time to successfully market tubes suitable for the requirements of this class of trade.

Later, concluding, after a careful study of the situation, that New England and the eastern states were not suitable for pipe manufacturing, the Flaglers decided to locate in the neighborhood of Pittsburgh. This city had already become the center of the rapidly growing iron and steel industry in America, for not only was it so situated that basic materials could easily be obtained, but its location was in close proximity to the then center of the oil industries.

Establishment of McKeesport Mills

In 1870 the Flaglers purchased the partially rebuilt works of the Fulton, Bolman Company, in McKeesport, where in 1862 the latter had established a ropewalk which was destroyed in 1866 by fire.

Shortly after locating in McKeesport, the Flagler Company was reorganized, and, after acquiring the exclusive rights to the Siemens patents for use in making pipe in the United States, was incorporated, with an increased capital, as NATIONAL TUBE WORKS COMPANY.

Reorganization

The growth of National Tube Works Company was gradual and not without its vicissitudes. The main part of the plant was destroyed by fire on April 9, 1873, but it was rebuilt and running again by September 1st of the same year.

The following year saw the addition of the butt-mills. In 1876 this department was destroyed by fire, but the Company, with its usual energy, rebuilt the mill and had it in operation within a very few months.

Butt-Mills and Rolling Mills Installed

Up to and including this time, all materials used in the manufacture of pipe produced in the various mills located in the Pittsburgh district were shipped to McKeesport by river.

The constant and ever-increasing demand for tubular products, particularly those of National Tube Works Company, soon warranted the establishment of the Company's own rolling mills. These were erected and put in operation in 1879.

Several years later, realizing that better pipe could be made by controlling the entire process, from raw materials to the finished product, the Company decided to erect several blast furnaces. By this time the plant had largely expanded, covering some 30 acres, and employing about 3,000 men.

The first plant of National Tube Company, Boston, Massachusetts, 1868

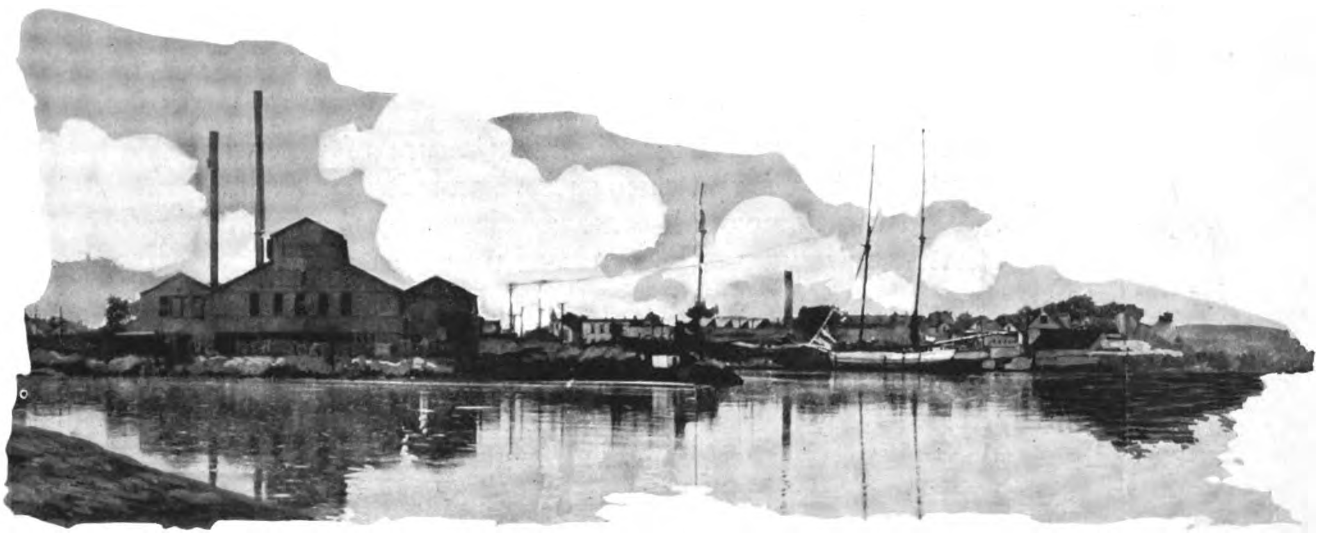
During the eighties, considerable experimentation was going on with the object of utilizing steel as a material for the manufacture of welded pipe and boiler tubes. Many unsuccessful attempts to substitute steel for iron had been made and whenever the subject was considered there were raised the usual stereotyped objections. The strong opposition to the idea that steel might be adapted to the pipe and tube industry fully as well as iron, suffered a set-back when Thomas J. Bray, Superintendent of the Tube Department, Riverside Works of National Tube Company, Wheeling, W. Va. (then Riverside Iron Works) presented the successful results of his attempt to manufacture pipe from steel.

Introduction of Steel Pipe

Mr. Bray's paper, "The Manufacture of Welded Steel Tubing", was read before the Engineers' Society of Western Pennsylvania, January 17, 1888. The following quotation from this paper shows how the entering wedge for steel was driven into the pipe industry:

First 500 Tons of Steel Pipe

> "Towards the latter part of August about thirty tons of steel were made and rolled into skelp and delivered at the Tube Works as a trial lot to be made into pipe. It was not necessary to brand or mark this material in any way, for the veriest tyro could distinguish it from iron, either in the strip, skelp or pipe by its clean, smooth and fine appearance.
>
> "The welders at the furnace said at the outset that it would not do; that it would not stand firm; and by reason of their prejudices against steel they subjected it to abuse by severe overheating; yet, strange to say, every piece of that lot made a sound, salable pipe, the welders remarking that 'it was the best material to weld they had ever handled.'
>
> "It was threaded and finished with the same success as it was welded. Of course we all thought that this was a 'fancy lot' or a 'happy hit'. The writer reported that it was just the material for the purpose, and far ahead of iron in every particular.
>
> "Soon after this several lots of one hundred tons each were made, and a record kept of the loss in the furnaces, crop ends, leakers, etc., which proved to be so very favorable to the use of steel for pipe making that the Company decided to manufacture steel pipes exclusively and to abandon the use of their forge and iron making plant altogether.



"Since the first introduction of Riverside steel tubing thousands of tons have been made and sold, with great satisfaction to the users thereof, and we are advised by parties in the East that they are using our standard steel pipe for hydraulic purposes at a pressure of one thousand pounds per square inch with success.

"The steel is made in a Bessemer Converter. The chemical analysis I am unable to give correctly at present, but regarding its physical properties, can unhesitatingly say, that it is the smoothest, toughest and kindest material to work with and to weld into pipe that has ever been tried or used by the writer.

"The accompanying samples, cut from ordinary Riverside steel pipe, clearly show the character of the material in the cold and hot states. The cold samples were flattened under a steam hammer. The washer was made out of a piece of four-inch steel pipe one and one-half inches long, by a blacksmith turning one edge of the pipe inwards and flanging out the other edge, then flattening it out into a washer as shown. The two goblets were made out of two-inch and four-inch pipe, respectively, necked down and welded to form a leg or stem, then flanged out for foot and mouth. This was done to show the amount of punishment the material can stand in a heated condition.

"Please notice the butt-weld samples particularly. It is well known that very little pressure is exerted on the edges of the seam in making butt-weld pipe, hence the weld is not a very strong one usually. There is considerable loss in iron butt-weld pipe by its splitting in the weld on being tested to the regulation pressure of three hundred pounds per square inch. With steel pipe this loss is reduced to less than one per cent by reason of the superior welding qualities of this steel over iron. I enclose with the samples a few crop ends. These show plainly how little is lost on each end with steel, and how well and kindly it welds.

"So flattering have been the reports from the users of this pipe that we can unhesitatingly pronounce it a merchantable success.

"Respectfully submitted,

"THOS. J. BRAY,
"Supt. Tube Dept., Riverside Iron Works, Wheeling, W. Va."

In all ages, improvements of any kind have met with opposition from the devotees of the methods then in use: in this day when steel tubular goods in this country are far in excess of other tubular materials, the fact that there was a time when steel was regarded as wholly unsuitable for pipe is about to be forgotten.

Introduction of Bessemer Steel for Pipe

It was not long after the manufacture of the first 500 tons of steel pipe at Wheeling until Bessemer steel for the manufacture of pipe was being introduced abroad with much success, and after considerable investigation the Company became convinced, by the results obtained, that steel would probably succeed wrought iron as basic material for pipe manufacture.

As the result of a report made by General Manager E. C. Converse and General Superintendent Peter Patterson on the foreign steel industry, the National Tube Works Company, about 1890, erected steel plants of the best existing construction, and rapidly developed improved economical methods of manufacture. All plants of the Company were reconstructed and equipped in accordance with the highest

prevailing mill standards. In 1899, after a general reorganization, it was decided to eliminate a portion of the then existing title of the Company, and it was styled NATIONAL TUBE COMPANY, its present title. It is an interesting tale of growth, from beginnings so unpretentious up to the present day mills which are equipped with the most modern type of machinery. The toilsome (often dangerous) manual labor methods have been replaced by modern mechanical means which ever insure a far better and more uniform product by reducing the personal element to a minimum.

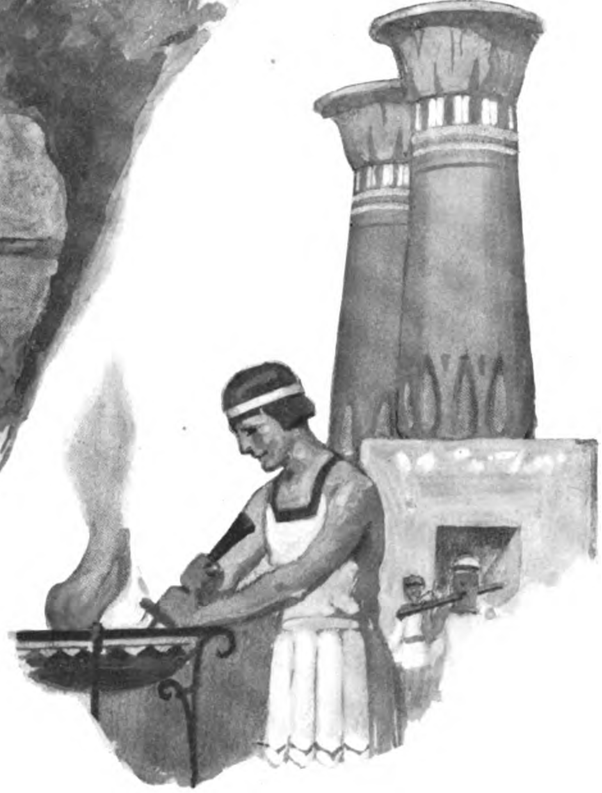
Extent of Present Mills

The present National Works of National Tube Company, on the site of the original mills, now occupies about 104 acres, and for nearly a mile is a succession of vast buildings designed and constructed according to the best modern mill design and practice.

One building alone, the main tube and pipe building, is nearly 1,600 feet in length and 600 feet in width, has a roof area of more than 20 acres, and is believed to be the largest manufacturing building under a single roof in the world. The plant is capable of giving employment to about 8,000 men.

As a fitting end to this brief retrospect of the growth of National Tube Company, a few words from its founder, J. H. Flagler, while on a visit to McKeesport, are particularly applicable:

> "The little National Tube Works that I founded in 1868, born in adversity under a small roof, 20 x 125, at East Boston, has grown and grown, till today, in its home within your midst, it needs no further comment from me. Great as its organization and management in the past, greater in its efficient and masterly management today, it stands before the world unrivaled."

Some ancient methods of iron manufacture and refining

Materials for Pipe

Early History of Iron Ore

ABOUT the first mention of iron is in connection with the third of those prehistoric ages known to geologists as the ages of Stone, Bronze and Iron. To endeavor to ascertain the length of time these periods covered, or how long ago they existed, has no real chronological value, for scientists have adopted no universal, synchronous sequence of these epochs.

The Iron Age probably was the connecting link between the prehistoric and the early years of historic times.

The metal has been referred to frequently in many ancient records, even as early as 3400 B. C. In Genesis IV, 22, mention is made of Tubal-Cain as an instructor in iron and copper. Iron was probably in general use in Europe long before the invasion of the Caesars.

The abundance of iron ore and its apparent easy access undoubtedly led to its general application in the arts of these remote periods.

Early Sources of Iron Ore

Assyrians, Egyptians and Greeks, all worked with the metal. The earliest source seems to have been India. The Greeks obtained most of their supply from the Chalybes, a people dwelling on the south coast of the Black Sea. Romans also used this source, besides exploiting Spain, Elba and Noricum.

The occurrence of iron in a free state is scarce, but plentifully found in a combined state, usually as oxides, carbonates, etc., and commonly known as magnetite, red or brown hematite, limonite, siderite and pyrite ores.

Its frequent and copious occurrences, its usefulness, its strength and its magnetic qualities (besides being the cheapest of the heavy metals) have led man, in the last few thousands of years, to adapt it to his uses, and its wonderful, varied and pronounced properties have helped to revolutionize the commercial world.

The first effort of primitive man to refine iron was probably by means of an open fire, or small cavity on the weather side of a bank, with an opening toward the prevailing wind, thus, in reality forming a simple forge. Later, possibly with this forge and the aid of a crude, valveless bellows, he created an artificial draught which hurried the process. There is little question among scientists that much of the earliest iron was, in fact, nothing more than a low grade of steel, due to the crude manner of manufacture employed by our ancient ancestors.

Crude Methods of Smelting

An important step occurred about the 4th century, when some forgotten genius designed valves for the bellows. But the passing centuries saw little or no improvement in the simple forges used, even though the influence of the Romans, who were active in the manufacture of iron, especially in England, France, Spain, Corinthia and the Rhenish districts, was great.

However, in the 14th century began the gradual displacement of the direct extraction of wrought iron from ore, by the intentional and regular use of the indirect method of first carburizing the metal, thus turning it into cast iron, and then converting it into wrought iron by remelting it in the forge. This displacement, which has been going on ever since, was the result of a desire to devise a more economical fuel system for refining the ore.

Beginning of Indirect Refining Methods

By the introduction of mechanical means in the 14th and 15th centuries, and through careful study of the results of various processes and scientific design of the forges, or furnaces, as they were then being called, the product began to assume a constant definite structure, which subsequently made possible those ornamental castings, common in the 14th century, and cannon, weighing as much as three tons, in the 16th century. With the more or less successful development of the indirect process, and its permanent establishment, came larger and higher furnaces demanding a greater supply of charcoal, which was used as the oxidizing agent. This caused such inroads on the forests of various countries that many laws were enacted prohibiting the cutting of timber for this purpose.

Experiments by Simon Sturtevant in 1611, Dud Dudley in 1619, and Stradda in 1625 to find a substitute for vegetable charcoal by using a mineral ore, met with little or no success, and it remained for Abram Darby, in 1735, to provide a successful substitute in mineral coke made from bituminous coal, for this purpose. From this time on, the development has been rapid, great advancement being made with the successful introduction of the "CRUCIBLE PROCESS" in 1740 by Benjamin Huntsman; the "PUDDLING FURNACES" in 1784; Aubertot's invention in 1811, which made use of the carbonic gases, heretofore allowed to burn uselessly at the top of the furnace; and Neilson's invention in 1828, of heating the blast, thereby reducing the fuel consumption.

Experiments and New Processes

Early Material for Pipe

The material used in the first welded pipe was wrought iron, this being the only suitable kind known to our forefathers. It first came on the market in this country early in the 19th century, and had no rival until well on in the 80's.

With the wonderful progress of the 19th century in the iron and steel industry it was to be expected that metal for manufacturing pipe would be discovered which, overcoming the inherent disadvantages of wrought iron, could be manufactured largely by machinery and yield a product in every respect typical of the 20th century advancement.

The method of making wrought iron was by puddling (a laborious hand process); the unit of manufacture was small, and uniformity almost impossible because the human element entered so largely into the manufacturing process.

Introduction of Bessemer and Open Hearth Processes

The "BESSEMER PROCESS" was invented and successfully introduced by Henry Bessemer in 1855, and in 1861 was followed by the "OPEN HEARTH PROCESS". These processes were so far in advance of previous methods that they revolutionized the commercial and industrial world and presented wonderful opportunities; but so engrossed were the makers in applying this new process to rails and other lines of steel production, that its value for the making of pipe on a commercial scale was not immediately appreciated. In fact, early attempts to make pipe from steel were almost failures.

Rapid Development and Success of Steel Pipe

The new material as then made could not be readily welded, could not be threaded with threading dies then in use, and numerous difficulties were met at every angle. The brilliant success attending the development of steel since the introduction of these processes, especially in material for pipe manufacture, is shown by the fact that in 1890 probably less than 5 per cent of the wrought tubular products made in this country were of steel, and in less than 30 years the situation had nearly reversed itself, until today, over 90 per cent of the wrought tubular products made in the United States are of steel.

Mining Mesaba ore by the "open cut" method

Manufacture of "NATIONAL" Modern Welded Pipe

The Ore

ONE of the more important factors in securing uniformity in a product of any kind is the use of uniformly high grade raw materials. As the principal raw material entering into the manufacture of "NATIONAL" Modern Welded Pipe is the iron ore, several grades of the best iron ore are blended in the proportions found to give best results in smelting. To insure a continuous supply of this high grade ore, complete control is exercised over the source of production by the same organization under which it is smelted, refined and rolled into finished pipe.

In the Mesaba range, where most of the ore used in "NATIONAL" Pipe is mined, the deposits lie in large pockets, or pits, under thick strata of earth, stone and gravel.

Drilling for Iron Ore

These pits vary in size and depth, some of them being two miles long, a mile wide and several hundred feet deep. Before mining, it is necessary to determine if a suitable quality of ore is obtainable, and so a hole is sunk through the barren upper strata by means of a drilling rig and casing—in much the same manner as an oil or water well is drilled. A small pipe is inserted in the casing and water is forced down through this pipe. The water rises to the top of the hole, between the outer casing and the smaller pipe, flushing out with it samples of whatever ore or soil exists at the bottom of the hole.

The samples obtained in this way are thoroughly mixed and then analyzed to determine whether a suitable body of ore lies beneath the surface; if the ore proves of suitable quality and there are indications of a sufficient quantity, the barren upper strata are stripped off by steam shovels and the ore is removed by

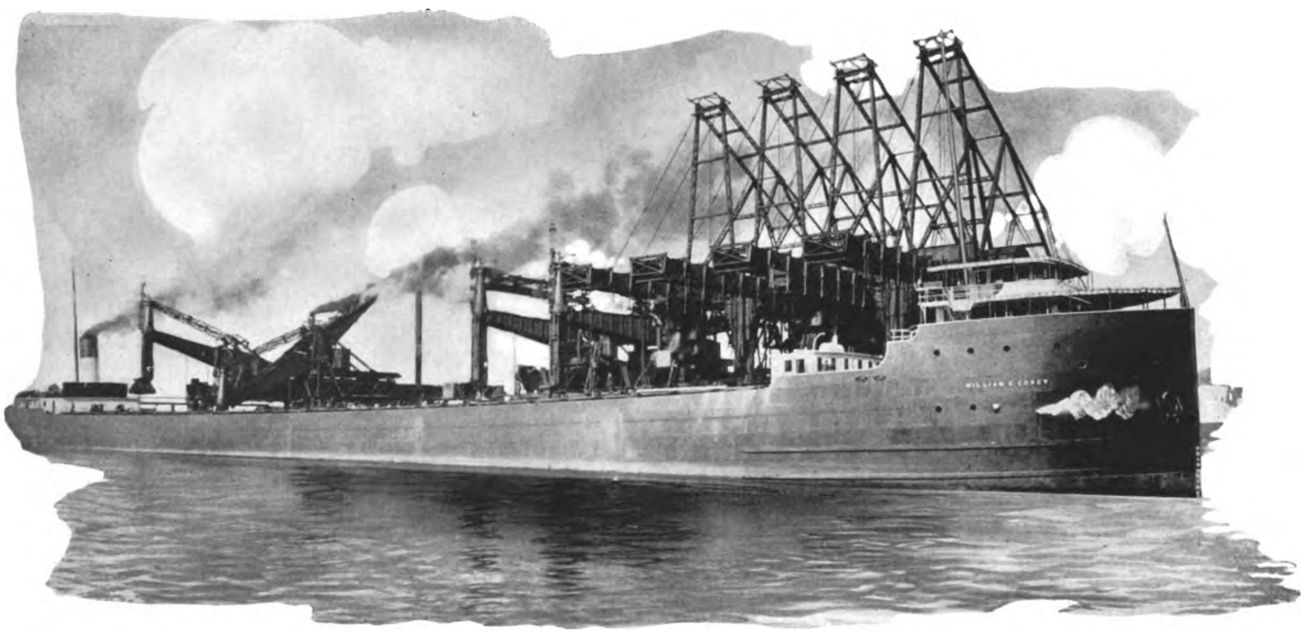
open excavating. This practice of open excavating is invariably pursued where the ore lies in long, wide and comparatively shallow deposits, and is known as the "open cut" method of mining. The ore, when mined, varies in appearance; it may be black or dark red or of a yellow color, much of it resembling iron rust, which it is, except that the red ore carries less water. The ore is scooped up by steam shovels and loaded into freight cars, which move over railroad tracks laid in the ore pit, and the ore is thus transported by the train load to the ore bunkers which are located at convenient points on the shore of Lake Superior.

"Open Cut" Method of Mining Iron Ore

These ore bunkers stand about a hundred feet above the water, and in some cases extend along the Lake port for half a mile. The carloads of ore run on railroad tracks above the bunkers, and the ore is dropped through the bottoms of the cars into large bins. Numerous chutes lead from the bottom of the bins, and down these chutes the ore passes to the holds of the boats. Due to this improved method of handling, it is now possible to load a large vessel, holding as much as 13,000 tons of ore, in the short time of 25 minutes. This accomplishment is best appreciated when it is considered that some boats of this type are about 600 feet long, 40 to 60 feet wide, rise 50 to 60 feet above the water when unloaded, and have 64 hatches through which the ore passes into the holds.

Improved Methods of Handling Ore

The loaded boats pass down the Great Lakes to the lower lake ports where the cargoes of ore are unloaded. By employing modern machinery it is possible to unload



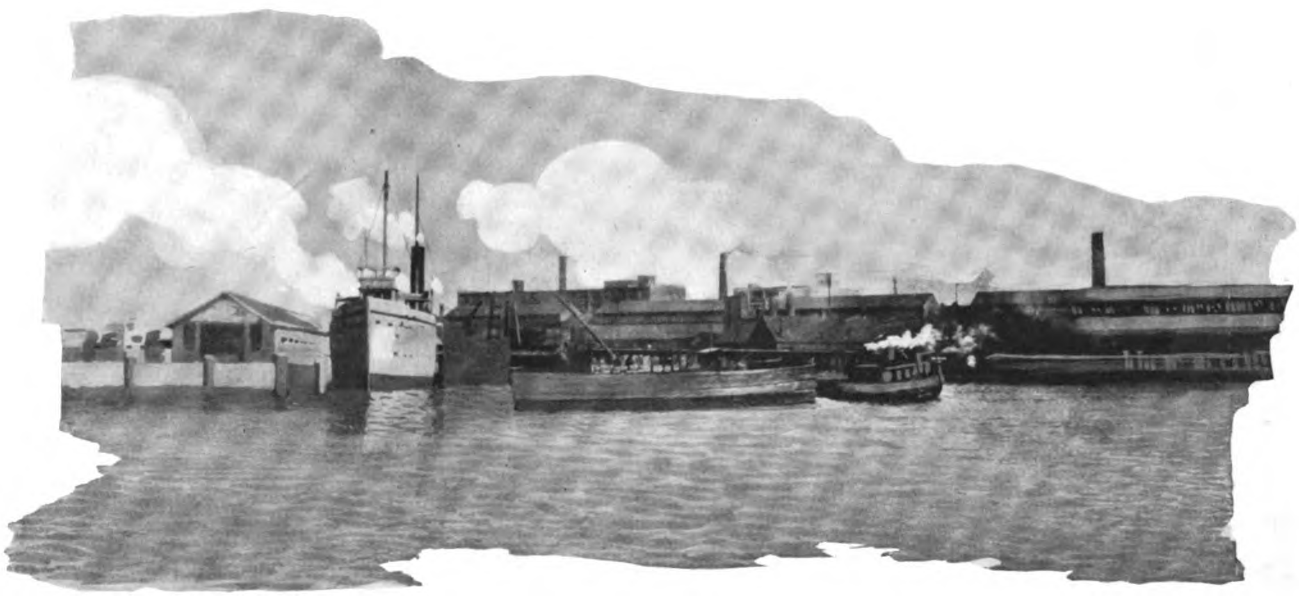
Unloading cargoes of iron ore at one of the lower lake ports

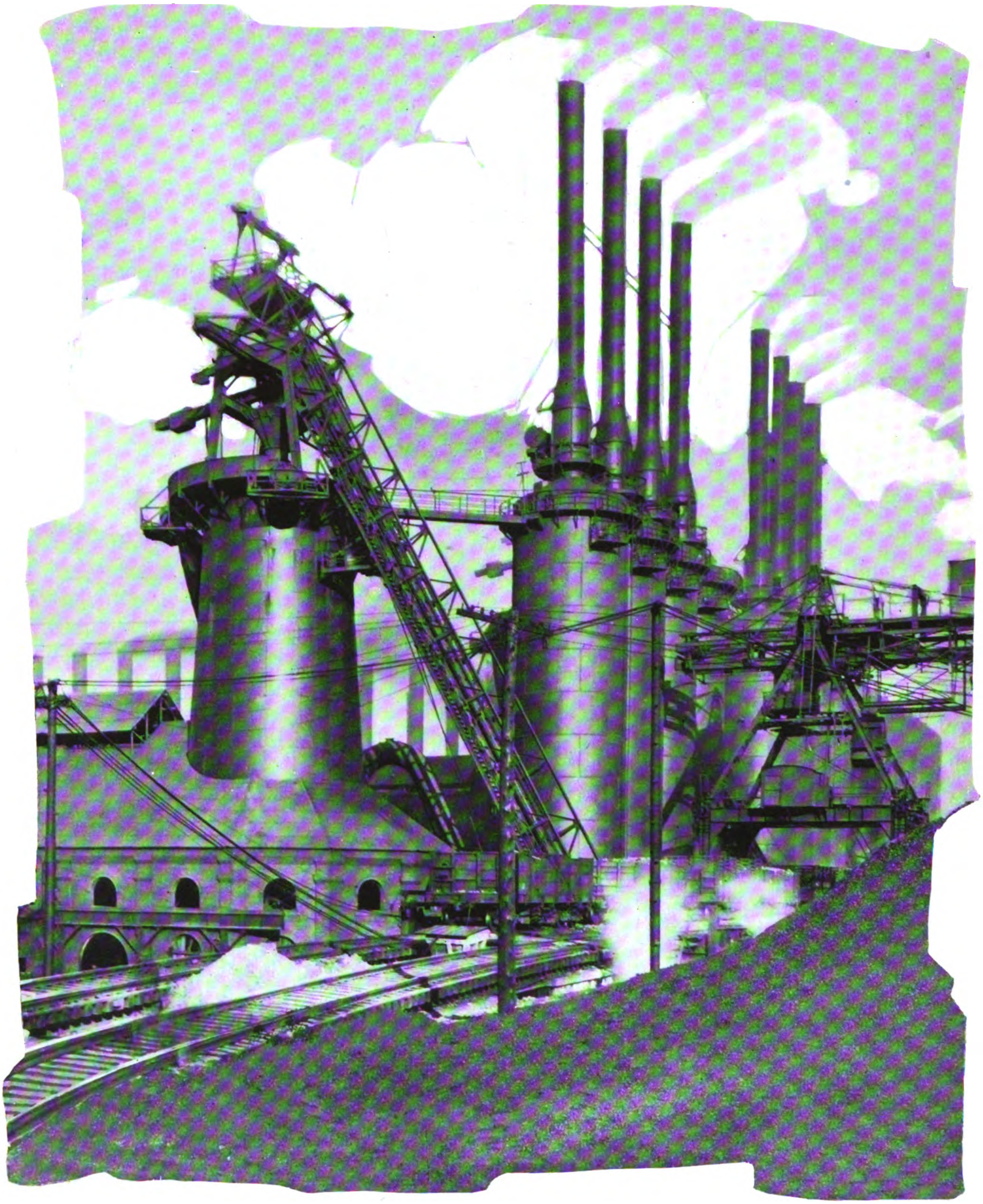
one of these boats of 8,000 to 13,000 tons capacity in from 4 to 6 hours. Grab buckets, or scoops, which pick up about 10 tons of ore at a time, are lowered into the hold of the boat from electrically-operated cranes. They transfer the ore directly to the stock piles of blast furnaces in the immediate vicinity, or to freight cars by which the ore is transferred to blast furnaces at points further inland. At the inland blast furnaces the ore is dumped out of the freight car by an automatic method that takes about 2 minutes and is stored in huge piles, above which travels an electric crane carrying a grab bucket. The function of the crane and bucket is to pick up the ore from the stock pile, or "ore farm" as it is sometimes called, and to deliver it to transfer cars which carry the ore to bins near the bottom of the blast furnaces.

Unloading Ore at Lower Lake Ports

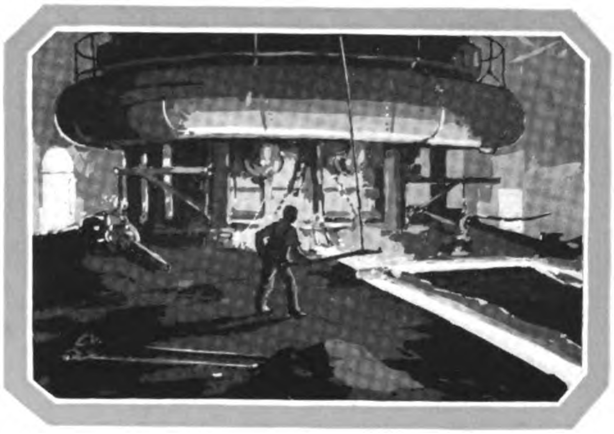
These ore bins are located beside others which hold coke and limestone, and are so placed that their contents may be emptied directly into small cars, or "skips", which carry the raw materials to the top of the blast furnace, into which they are dumped. The "skips" travel up an inclined track, two "skips" being used at each furnace, the one traveling down and acting as a counterbalance as the other travels up with its load.

The ore in its natural state is firmly combined with oxygen and various foreign elements, and to separate the metal from this combination requires intense heat and the presence of materials which, under proper conditions, have a stronger attraction for the foreign elements in the ore than they have for the metallic elements. The conditions for thus separating the metal from the foreign elements are provided by the blast furnace.





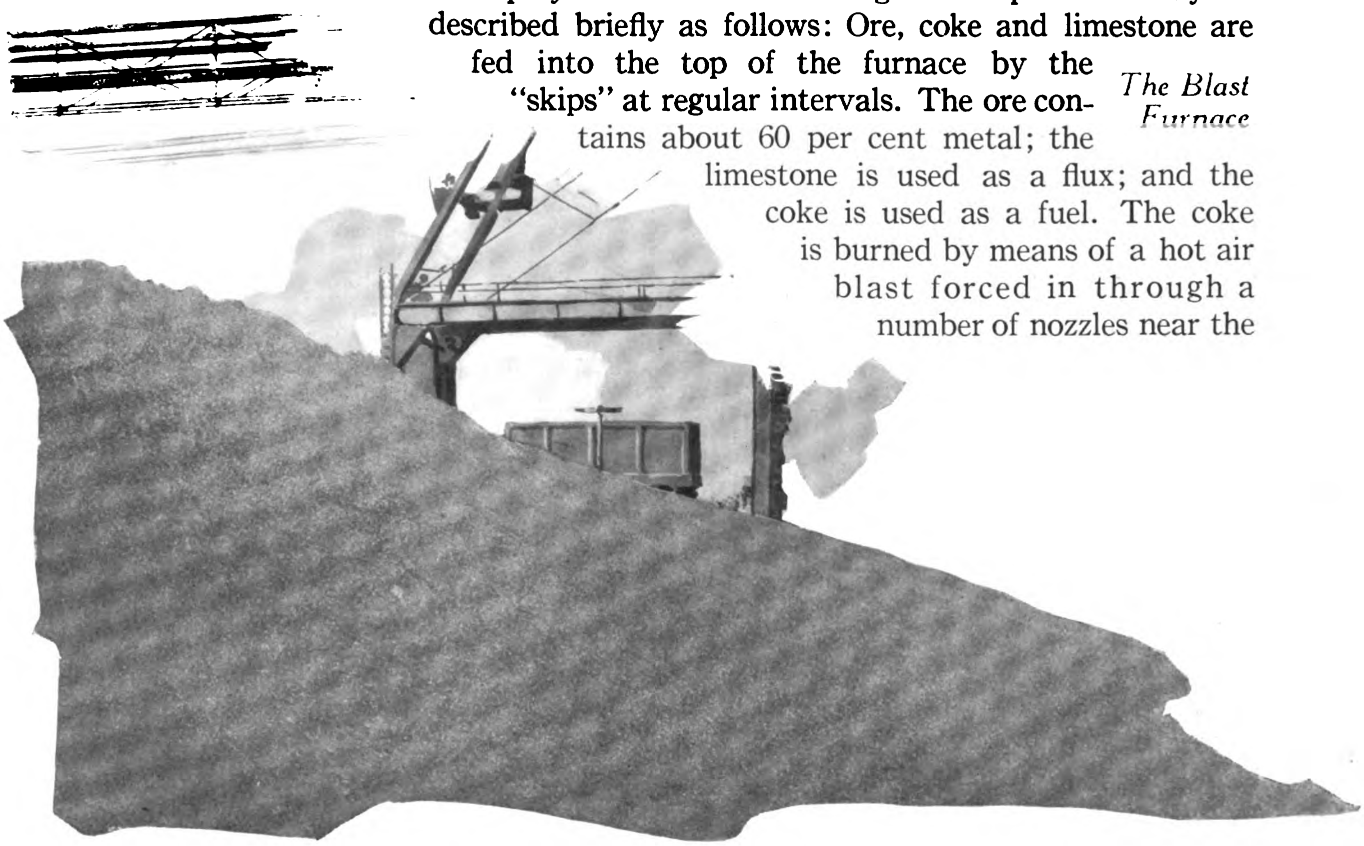
Blast furnace and stock of iron ore

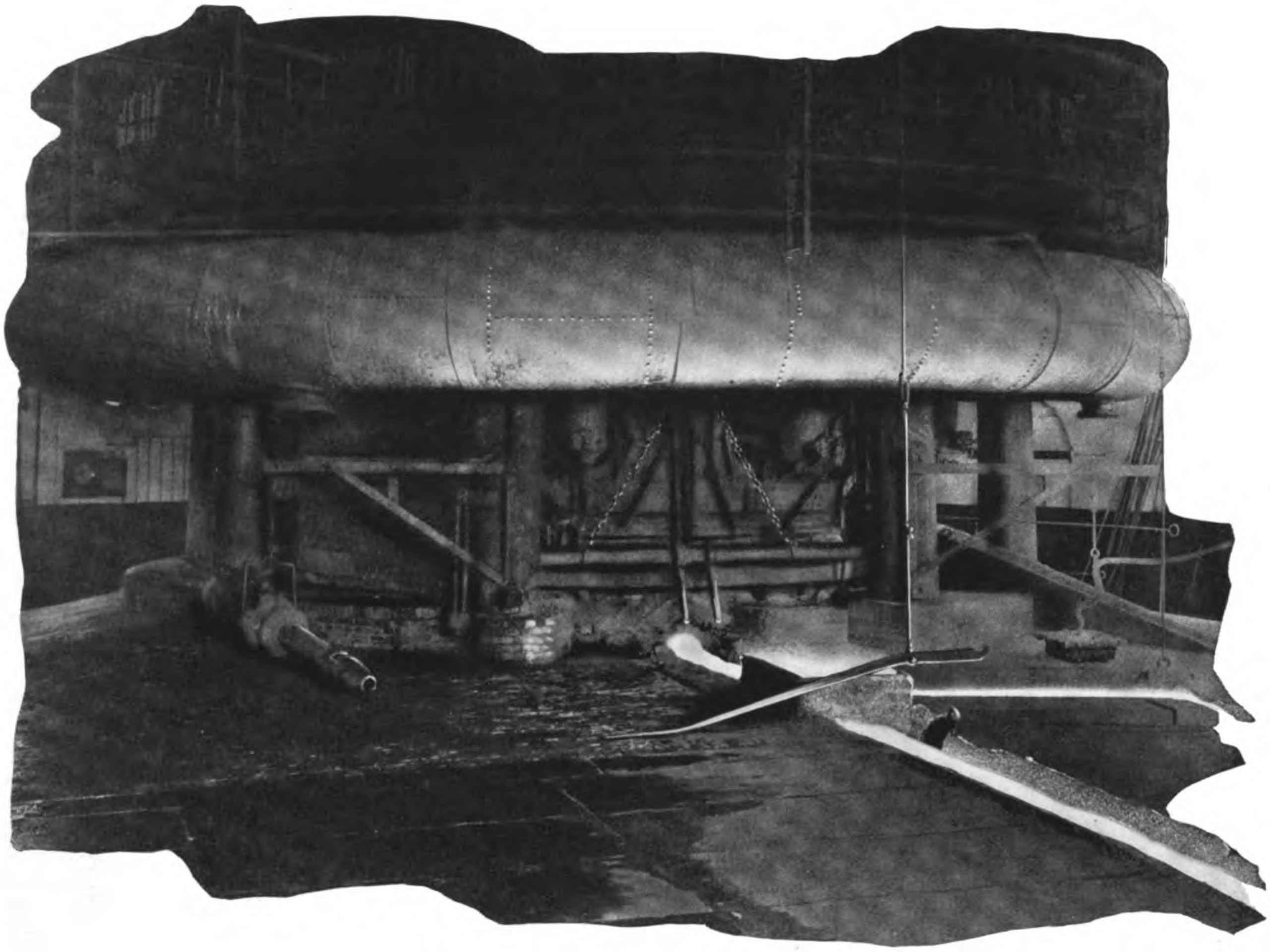


The Blast Furnace

THE blast furnace is a stack-shaped structure approximately 90 feet high, with an inside diameter at the base of about 22 feet. It is lined with brick of special composition, is strongly braced for the heavy burden it carries, and is cooled by a circulating water system to prevent destruction by the intense heat employed to smelt the charge. Its operation may be described briefly as follows: Ore, coke and limestone are fed into the top of the furnace by the "skips" at regular intervals. The ore contains about 60 per cent metal; the limestone is used as a flux; and the coke is used as a fuel. The coke is burned by means of a hot air blast forced in through a number of nozzles near the

The Blast Furnace





Molten metal flowing from blast furnace

bottom of the furnace, at the rate of 40,000 cubic feet per minute and under a pressure of about 15 pounds per square inch. The hot air blast thus applied is produced by blowing engines that force the air through a series of four furnaces.

Molten Metal

These furnaces, or "stoves" as they are called, are situated close to the blast furnace, and the necessary fuel which they consume for heating the air is obtained from the blast furnace in the form of waste gases produced by the burning of the coke. The interior of each stove consists of a checker-work, or baffle, of fire-brick. When this checker-work has been highly heated by the gas from the blast furnace, the gas is shut off, and the air is forced through the stoves by the blowing engines. In passing through the preheated checker-work of the stoves, the air becomes white hot, and when it enters the blast furnace it causes the coke to burn with an intense heat, thus melting the charge in the blast furnace. The charge finds its way to the bottom of the furnace in the form of molten metal and a liquid cinder, or "slag", which is formed by the limestone combining with the foreign elements of the ore. This liquid slag is drawn

off at intervals of about two hours, and being an undesirable element in the steel used for "NATIONAL" Modern Welded Pipe, it is discarded.

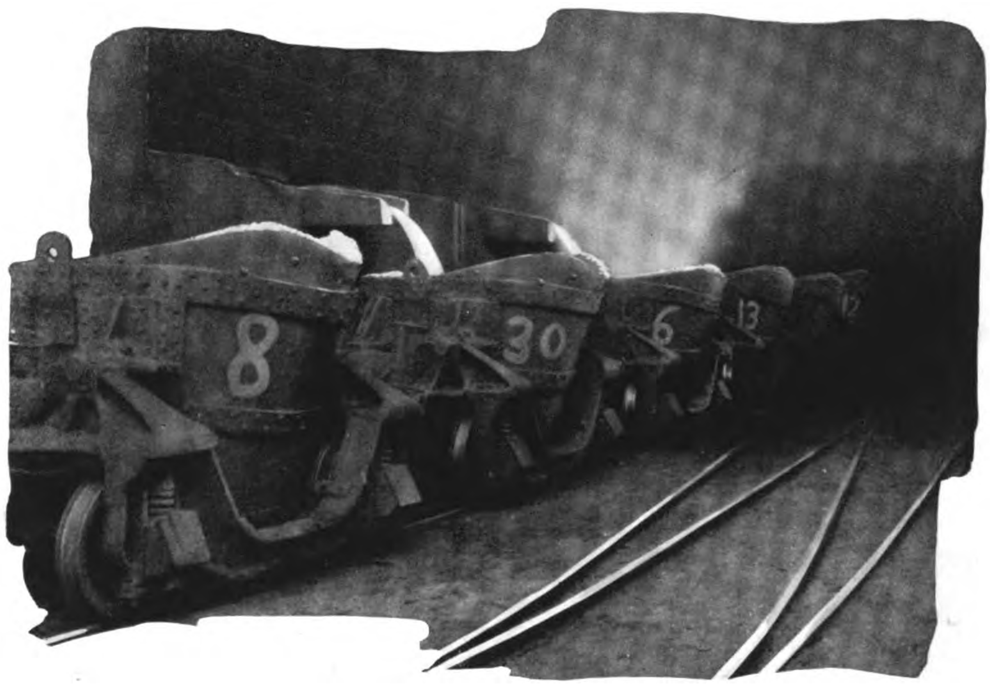
From Ladle-car to Mixer

The liquid metal which remains is drawn off every four hours into ladle-cars which run on a narrow-gauge track and convey the material to a mixer into which the contents of a number of cars are emptied and are thoroughly mixed by a continuous, gentle agitation, to insure uniformity of the whole bath. The mixer has sufficient capacity to mix a large quantity (200 to 500 tons) of metal at one time, and it is this policy to secure uniformity from the first to the last stages of manufacture that accounts for the uniformity of finished "NATIONAL" Modern Welded Pipe.

The hot liquid metal which is conveyed to the mixer from the blast furnace is about 94.5 per cent pure, the remaining 5.5 per cent consisting of carbon, silicon, manganese, phosphorus and sulphur. These elements, even in minute quantities, greatly influence the character of the metal, and various processes have been devised for reducing or removing them; perhaps the best known and most widely used of these is the Bessemer Process.

The thoroughly mixed metal is poured from the mixer into ladle-cars, somewhat smaller than those which carry the metal to the mixer and holding just enough metal for one charge of a converter. The Bessemer Converter is a large, pear-shaped receptacle, lined with refractory material such as fire-brick, capable of containing and refining ten tons of metal at one time. In operation, the converter is tilted to a practically horizontal position, and a ladle of molten metal is poured in at the top. The converter is then tilted upward, and air under pressure of about 25 pounds

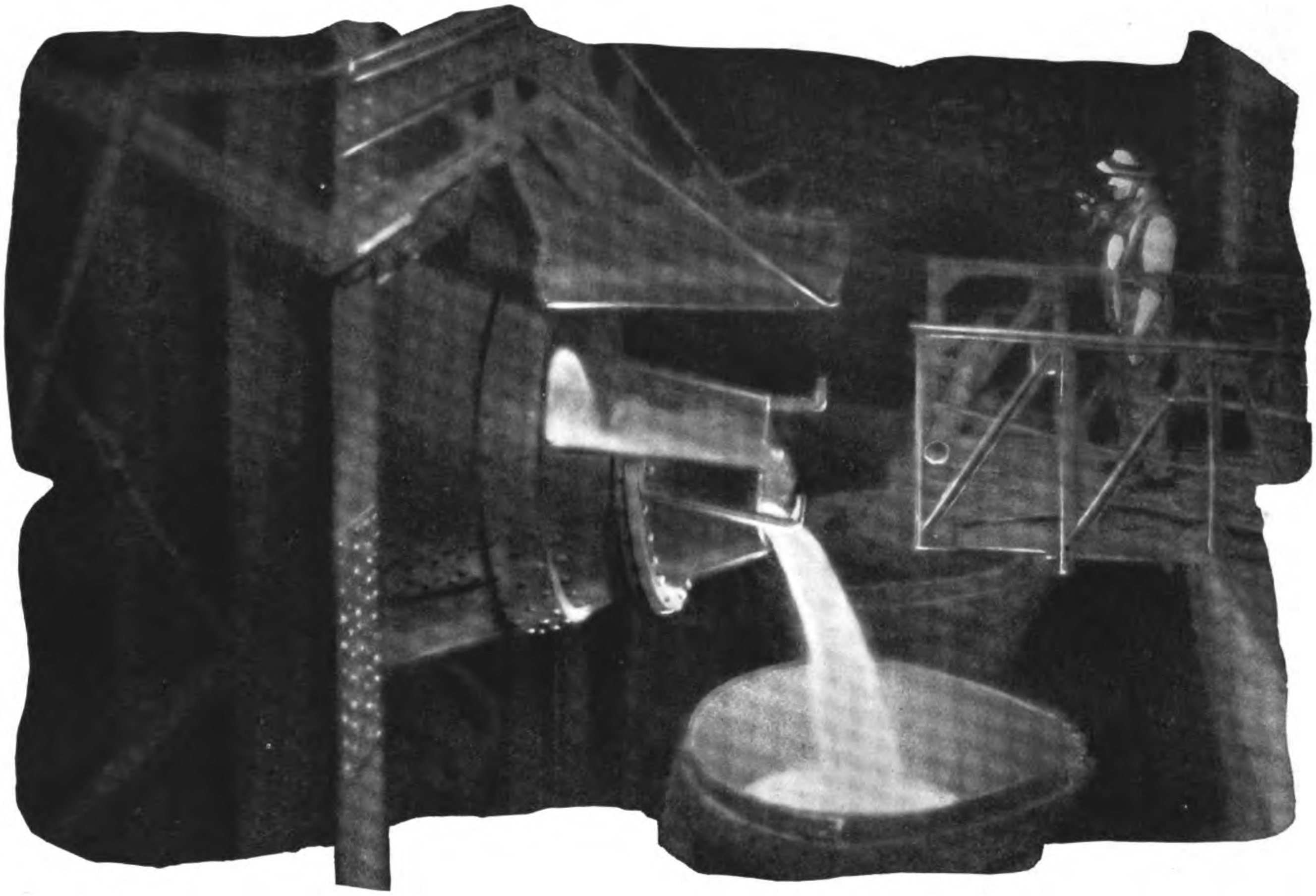
Filling ladle-cars with metal from blast furnace



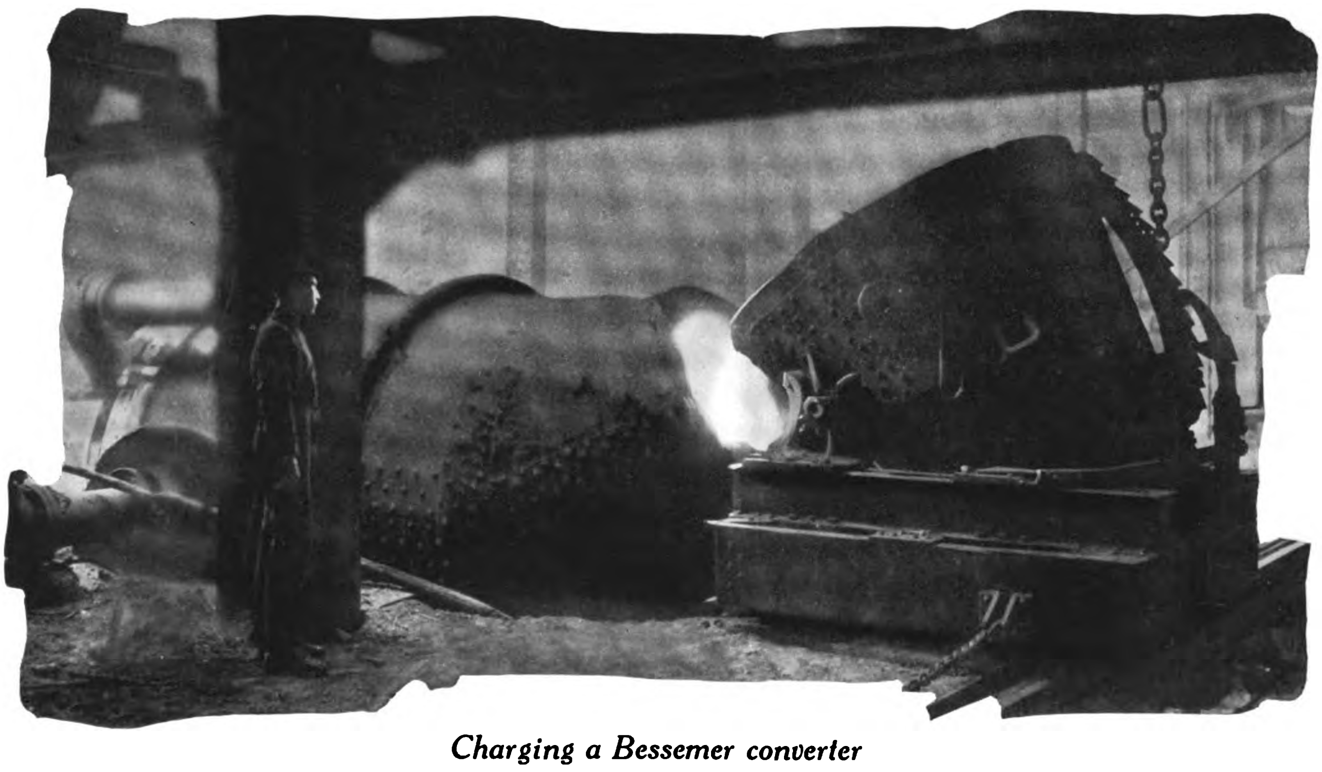
Pouring metal from ladle-cars into mixer

per square inch is forced up through holes, or tuyeres, in the bottom. As the air passes through the metal, a violent reaction is set up by which the impurities and most of the carbon are eliminated, and the result is the highly-refined material known as Bessemer Steel. The oxygen of the air first burns away the silicon and manganese, then the carbon, and finally when the carbon is almost entirely removed, the metal itself begins to oxidize. The color and density of the flame coming from the mouth of a converter clearly indicate to the skilled operator what is going on inside. It requires from eleven to fifteen minutes to complete a "blow", the end of the reaction being manifested by a decided drop in the intensity of the flame. Most of the heat required for the conversion of the molten mass into steel is furnished by the oxidation of the impurities in the metal itself, and as a matter of fact, a bath of steel in a Bessemer Converter at the end of the operation is several hundred degrees hotter than at the start. At the conclusion of the "blow", a certain amount of ferro-manganese is added to eliminate any remaining oxygen, to give the small amount of manganese and carbon required in the finished steel, and to improve the working qualities.

The Bessemer Converter



Taking metal from mixer to be refined in converter



Charging a Bessemer converter

A Bessemer converter in operation

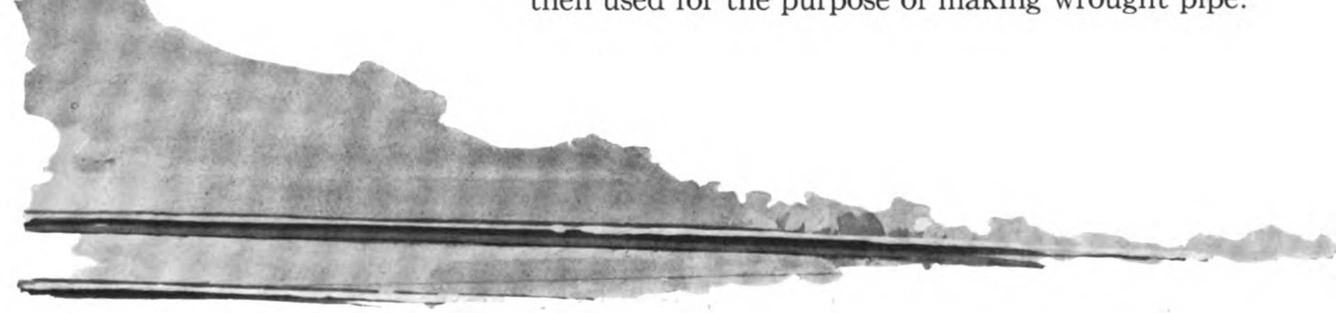
Evolution of the Bessemer Process of Refining Steel

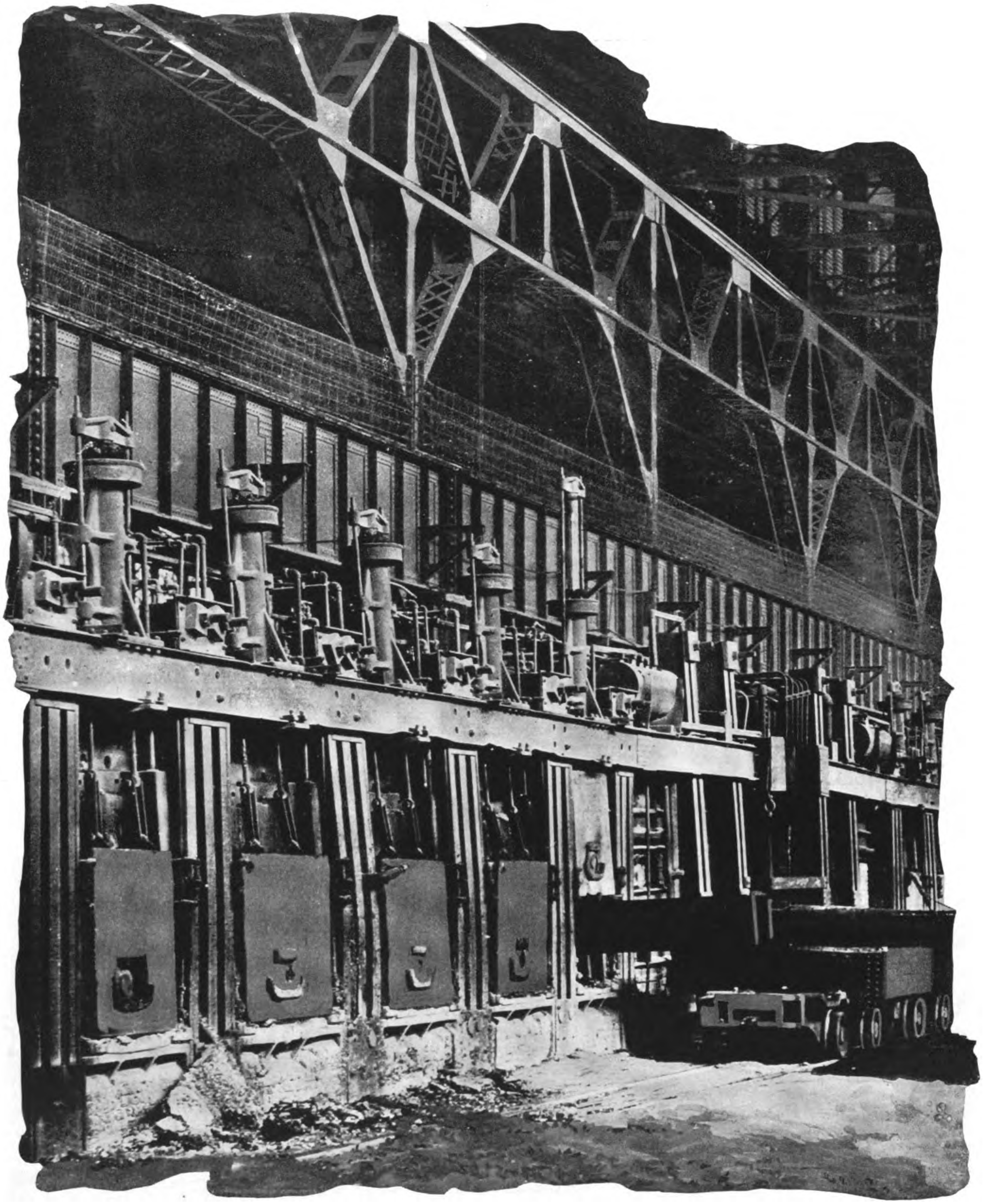
ABOUT the middle of the last century, an urgent need arose for material which would be as soft as some forms of iron, as strong as steel, and lower in cost than either—steel at that time selling for about $300 per ton.

Development of Bessemer Process

This urgent need and the high cost of the kind of steel then made led to the discovery that the crude product of the blast furnace could be refined by forcing air through the molten metal without the use of any externally supplied heat. It was found that the oxygen of the air combined with the silicon, manganese and carbon in the metal, oxidizing these elements and converting the metal into refined soft steel. (When the metal is completely refined by the Bessemer Process, it is practically free from carbon and cinder and is especially adapted to the manufacture of pipe.)

Although Bessemer, in describing the product of his new refining process, did not refer to it as "steel", which name had previously been applied only to the high grade products made by the crucible process, the term was broadened to include the metal produced by the Bessemer Converter, probably because of the esteem in which steel was held at that time and because of the evident superiority of the Bessemer steel over other materials then used for the purpose of making wrought pipe.

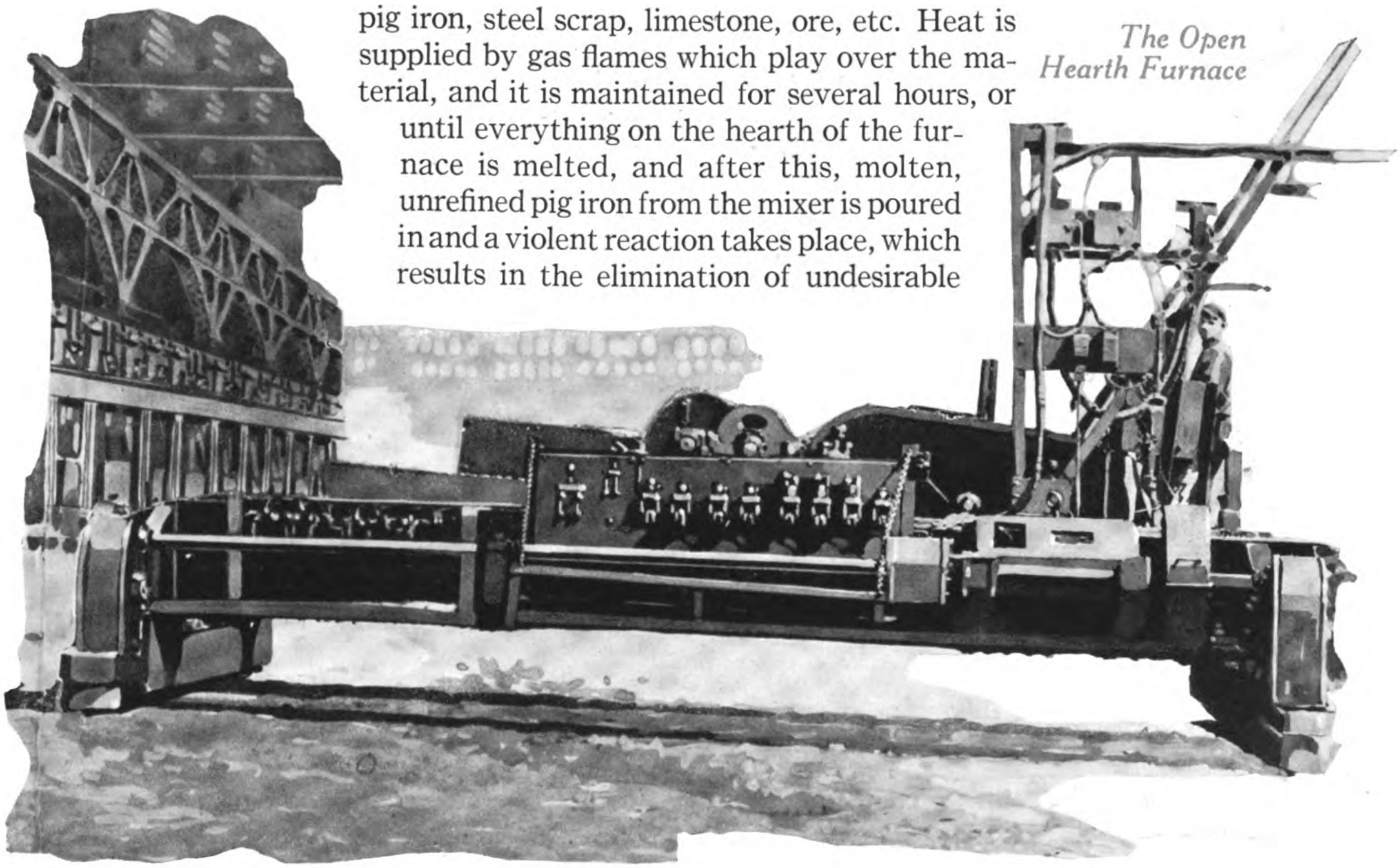




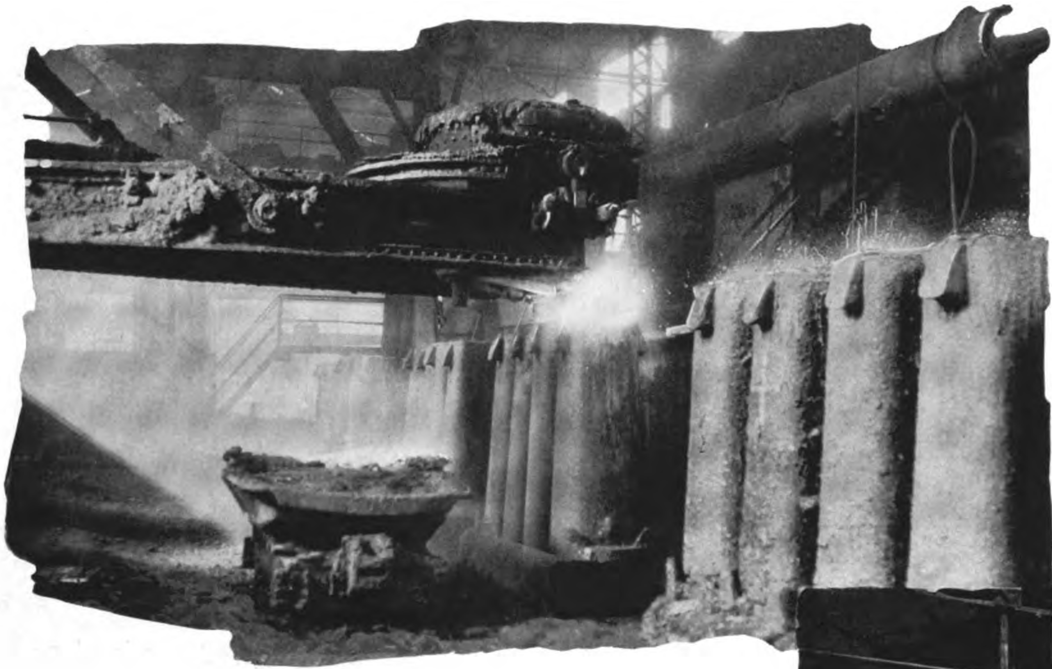
Charging open hearth furnaces

Open Hearth Process of Making Steel

STEEL for the manufacture of "NATIONAL" wrought tubular products is also made by the Open Hearth Process. In this process a large rectangular-arched, regenerative furnace is used. Like the Bessemer Converter, this furnace is lined with a refractory material, and on the hearth of this furnace is charged pig iron, steel scrap, limestone, ore, etc. Heat is supplied by gas flames which play over the material, and it is maintained for several hours, or until everything on the hearth of the furnace is melted, and after this, molten, unrefined pig iron from the mixer is poured in and a violent reaction takes place, which results in the elimination of undesirable

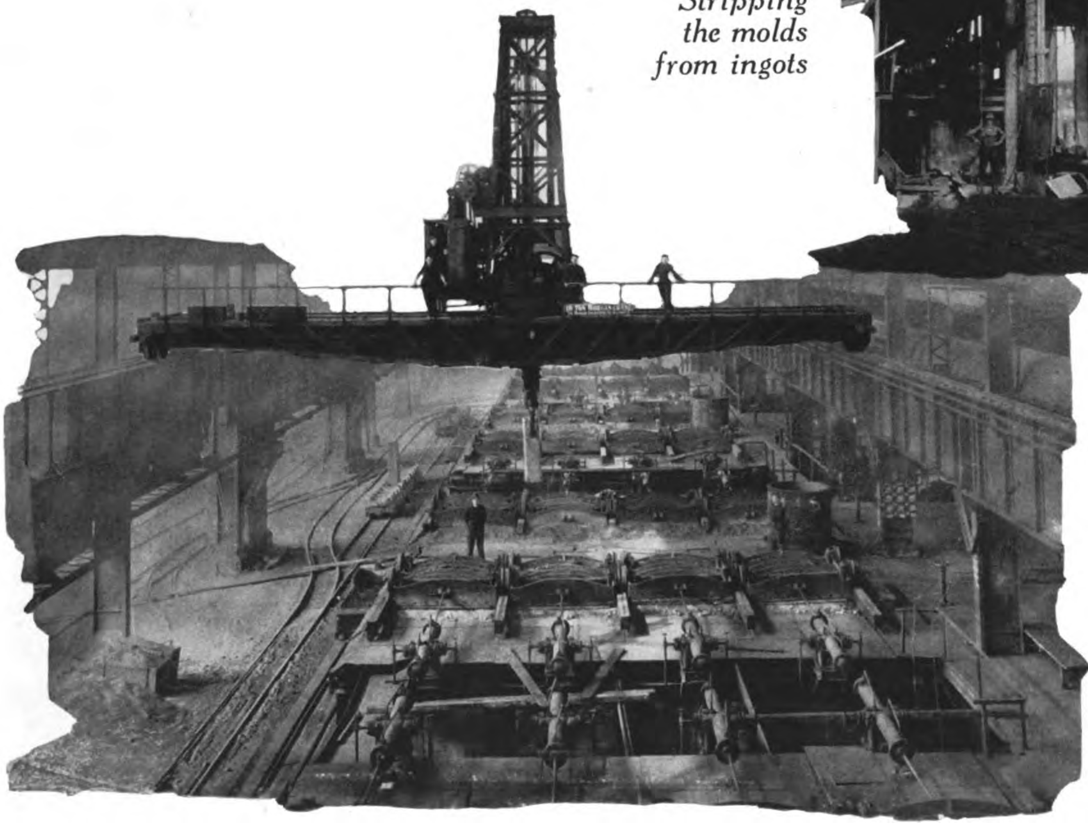


The Open Hearth Furnace

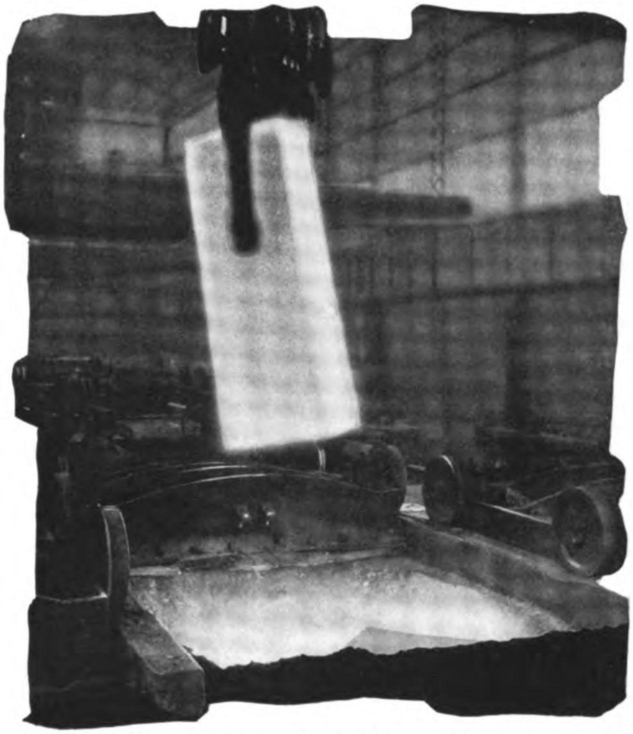


Pouring metal into molds to form solid ingots

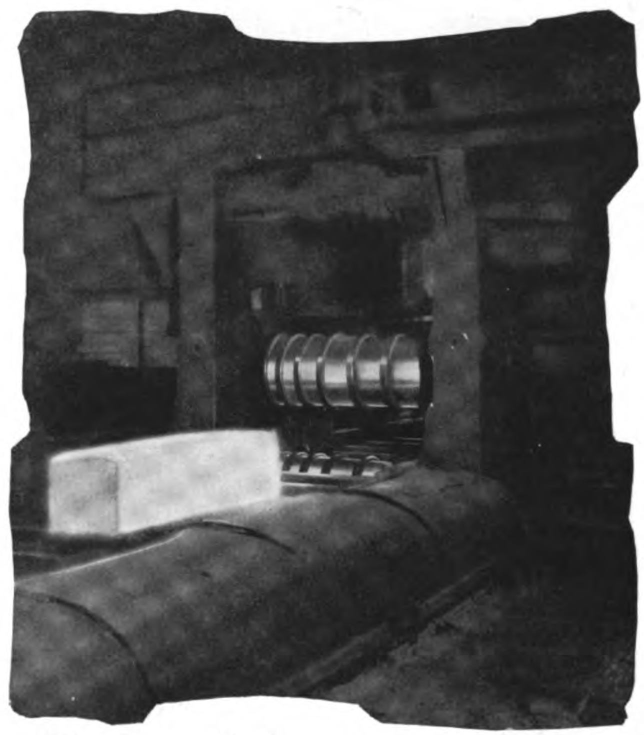
Stripping the molds from ingots



Soaking pits, or furnaces, where ingots are heated for rolling operations



Removing a heated ingot from ***soaking pit***



Blooming mill where ingots are rolled into ***blooms, or slabs***

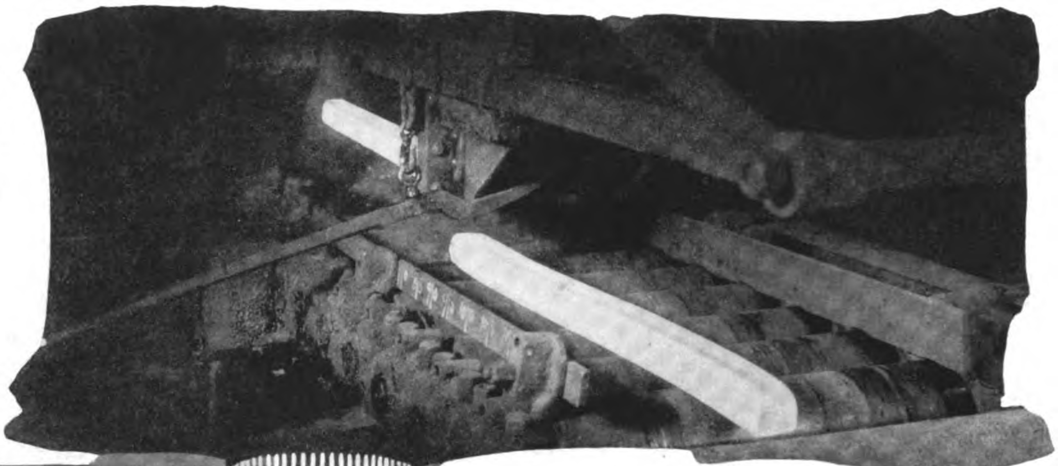
matter, leaving a steel highly uniform and of exceptional quality. The value of material made by this process is not only apparent in the manufacture of lap-weld pipe and tubes, but it is largely through the development of this process that the production of seamless tubes on a commercially practical scale has been made possible.

When metal is refined by either the Bessemer or the Open Hearth Process, it is drawn off into large ladles having a tap-hole in the bottom through which the metal is "teemed", or poured, into large molds, to form ingots.

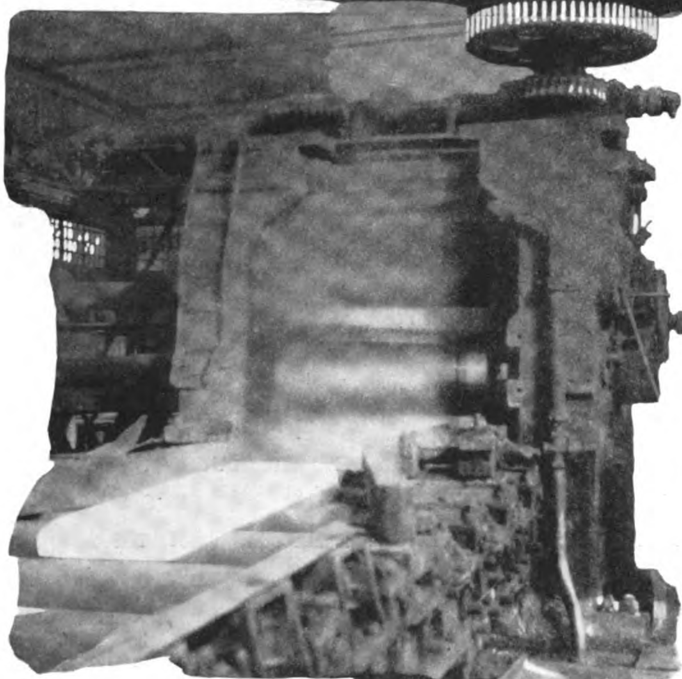
By running the metal into the molds from the bottom of the ladle, any impurities, which may have been poured in from the converter or the open hearth furnace, rise to the top of the ladle and are easily removed; if any such impurities should flow into an ingot mold, they rise to the top of the mold and are eliminated when the crop-end of the ingot is removed.

The ingot molds are carried on small iron cars, running on a narrow-gauge track, and, immediately after being filled with metal, are pulled out of the "cast room" by a small locomotive and allowed to cool somewhat. They are then switched to another part of the plant where the molds are removed from the solid ingots by a "stripper". This machine consists of a pair of large crane-operated tongs which automatically remove the mold and leave the ingot in an upright position on the car.

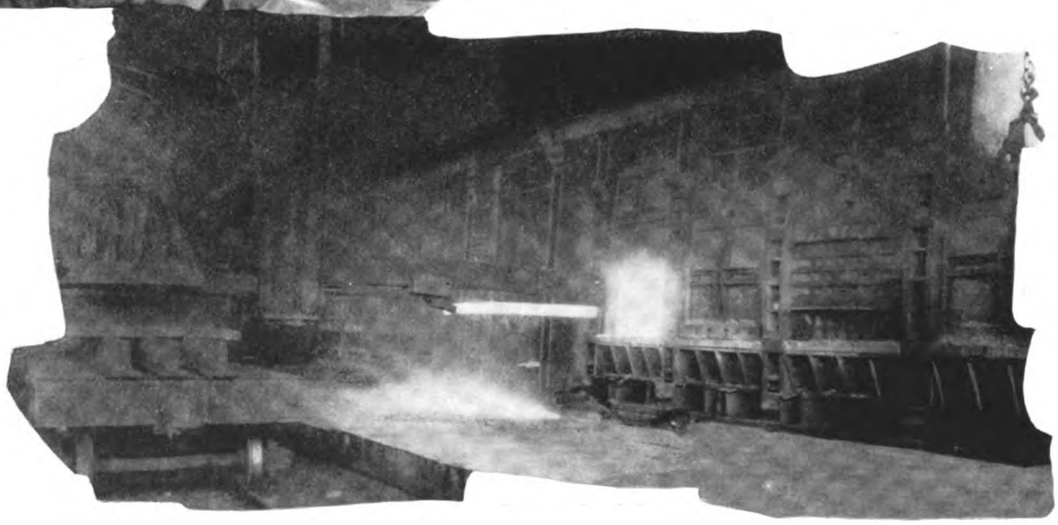
Removing Molds from Ingots



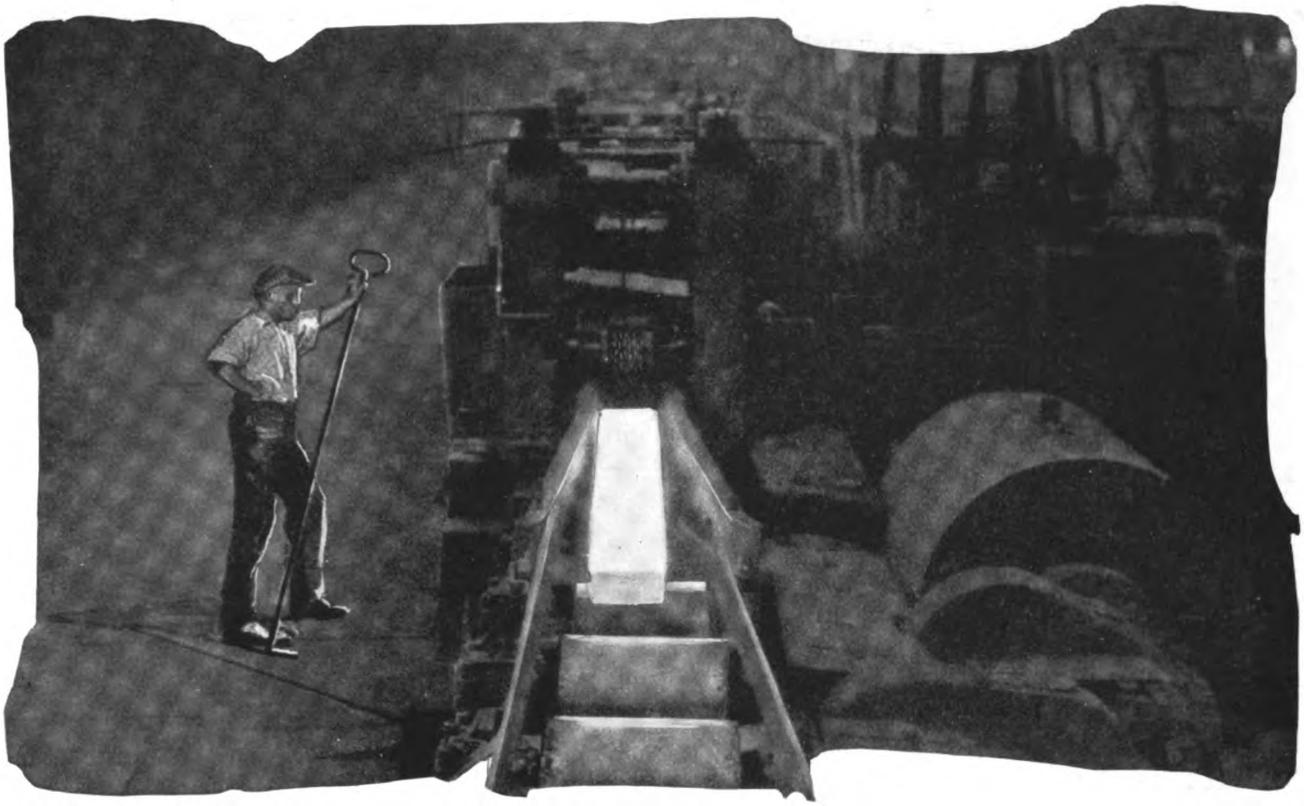
Cutting blooms to proper size



Rolling blooms into plate for large pipe



Heating blooms prior to rolling into plate



Spellerizing rolls, employed to give a uniformly dense texture to pipe metal

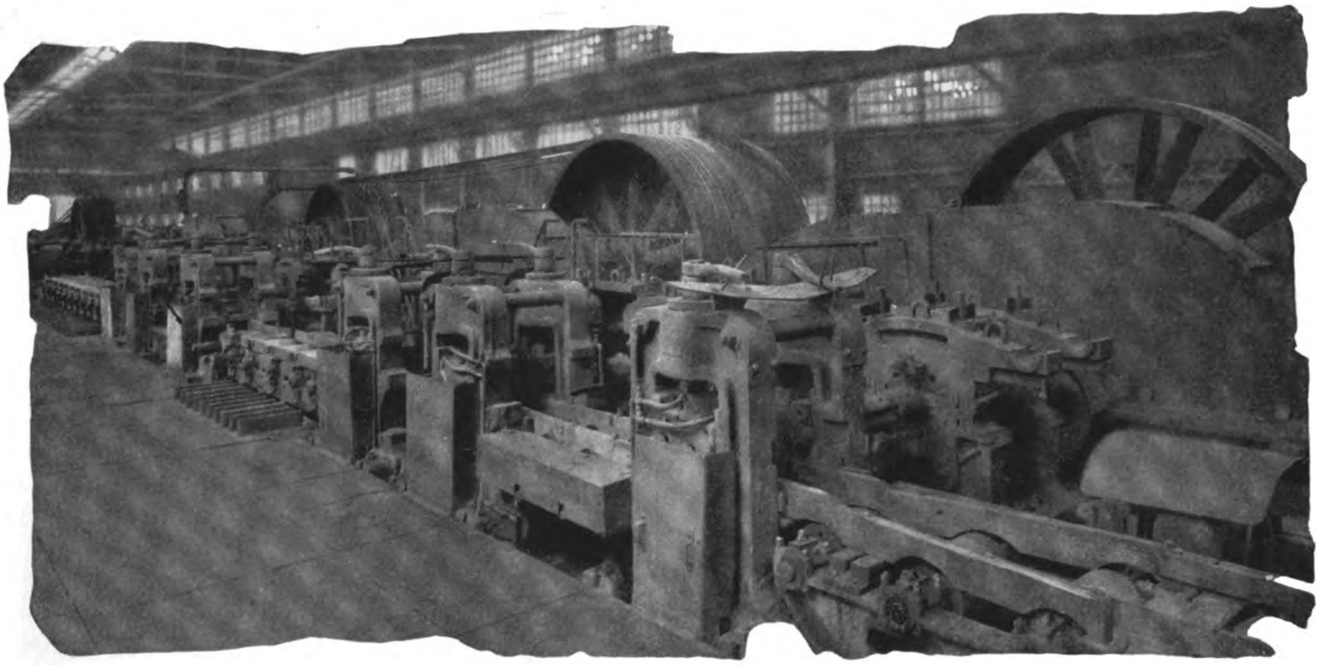
The ingots, which have been allowed to cool somewhat to facilitate stripping, must be brought up to uniform temperature to be in suitable condition for rolling, hence they are placed in a "soaking pit", or furnace, where they are heated uniformly throughout to the temperature required.

Heating Ingots

When the ingots have reached the desired temperature, they are lifted from the soaking pits by large tongs and placed upon an ingot buggy which transfers the ingot to the rolling table of a bloom mill. Here large rolls, driven by tremendous power, reduce the ingot to blooms, or slabs, of different sizes, according to the size of pipe to be made, the ingot first being elongated by rolling and then cut to the proper length, while hot, by a heavy shear, with apparently the same ease as if the metal were so much candy. The blooms thus produced are carried to reheating furnaces, which are located at one end of the plate, or "skelp", mill where the blooms are rolled into the long strips, or plates, known as "skelp", and from which the pipe is directly made.

Rolling Ingots into Blooms and Skelp

The machinery which rolls the blooms is somewhat lighter than that which rolls the ingots, and in the more modern plants is arranged in continuous order. That is, a heated bloom is placed in one end of the mill and travels through several sets of rolls, continuously in one direction, emerging from the mill in the form of finished plate, or skelp.



Continuous mill in which plate, or skelp, is made in one continuous rolling operation

It is in the skelp rolling mills that "NATIONAL" Pipe is given the mechanical roll-knobbling treatment known as Spellerizing.

Additional Operations in Finishing Skelp

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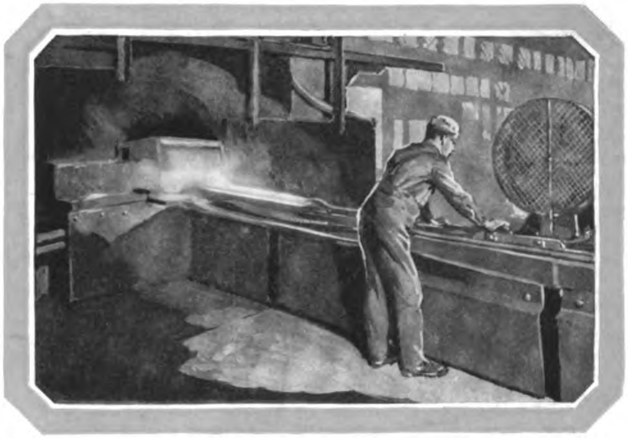
The length, width and thickness of the skelp is closely calculated for each size and kind of pipe, and the rolls of the skelp mills are adjusted to produce the exact dimensions desired. Plates for making into lap-welded pipe have the edges scarfed, or beveled, where they are to overlap, in order that the pipe will be no thicker at the welded seam than elsewhere, and for other practical considerations in welding. Skelp used for making butt-weld pipe has the edges slightly beveled, to compensate for any circumferential stretching that may occur when the plate is drawn through the welding die, and to insure true and even butting of the edges which are welded. ~~It is in the skelp mills also where the name "NATIONAL" is rolled in raised letters on the skelp for butt-weld pipe while it is still hot.~~

Finally, one end of each piece of skelp for butt-weld pipe is trimmed roughly to a point and pressed to a shape that permits its easy and proper starting through the welding bell, when gripped by the welding tongs.

"NATIONAL" Pipe is made by either of two processes—known as butt-weld and lap-weld. All sizes up to and including 1¼-inch are made by the butt-weld process; sizes 1¼ up to 3-inch are made by either process; and all sizes above 3-inch are made only by the lap-weld process.



Butt-weld Process of Making "NATIONAL" Pipe

(*Employed for sizes $\frac{1}{8}$ to 3-inch, inclusive*)

SKELP made in the manner just described is mechanically charged into a long furnace and raised to a suitable temperature for welding. The furnace is somewhat longer than the skelp, and has a narrow opening at each end, just large enough to permit the entrance and withdrawal of the skelp. The charging mechanism is situated at the rear of the furnace and the drawing, or welding, mechanism at the front. 70

Drawing Standard Butt-weld Pipe

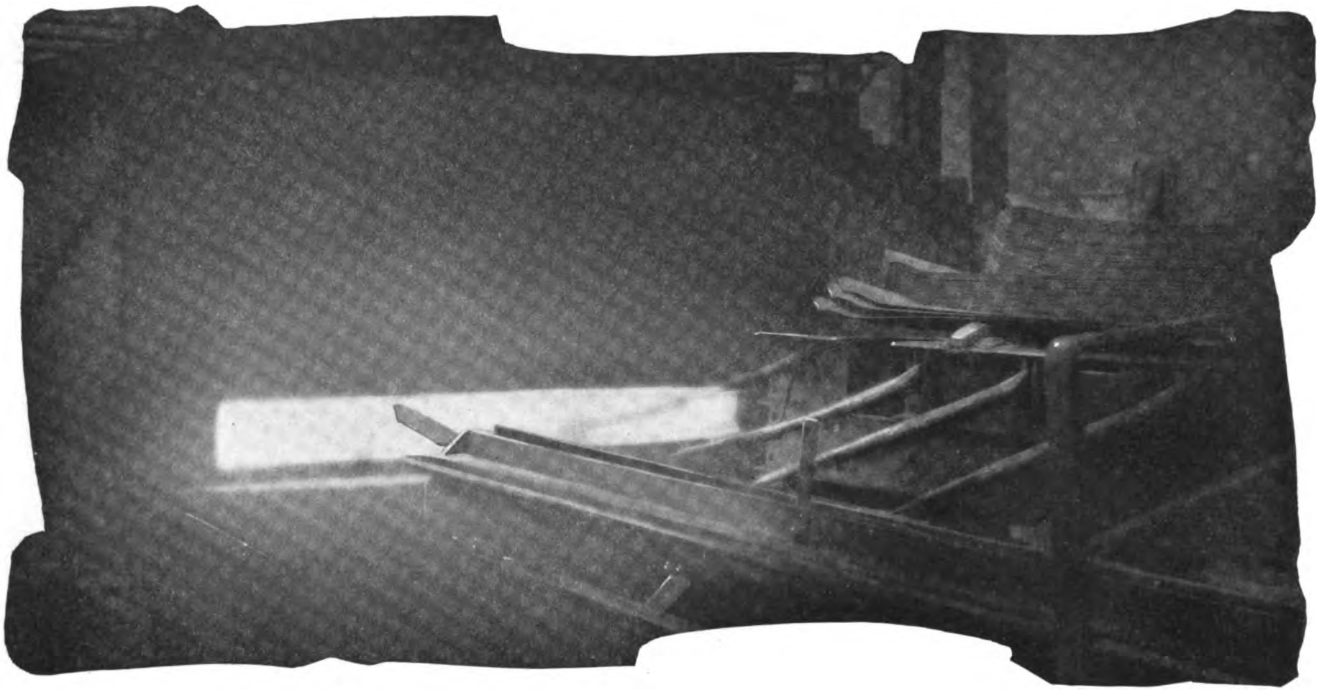
When the skelp in the furnace has reached the proper heat, the trimmed and pressed end is grasped by long-handled tongs and pulled through a die, or bell, which has a circular opening slightly larger in size than the pipe is to be when finished. The tongs are then connected to a continuously traveling chain in a draw-bench, and by this means the pipe is pulled through the die for its full length—which may be from approximately 20 to 40 feet. 95

For some sizes of pipe, the skelp is drawn through two bells consecutively at one heat, one bell being placed just behind the other, and the one through which the pipe passes last being slightly smaller in diameter than the other. 40

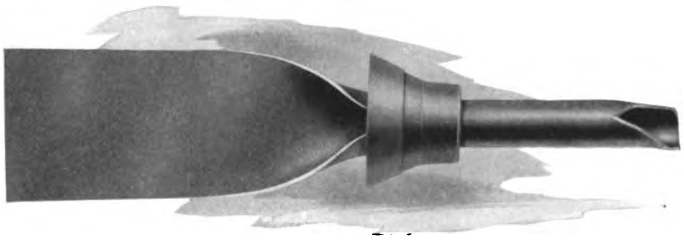
The skelp passes through the bell or bells, as the case may be, and is bent into tubular form. As the width of the skelp is slightly greater than the inside circumference of the bell the skelp is snugly encircled when so bent. The edges are thus forced to butt squarely and are pressed together into a sound weld. 60

Drawing Double Extra Strong Butt-weld Pipe

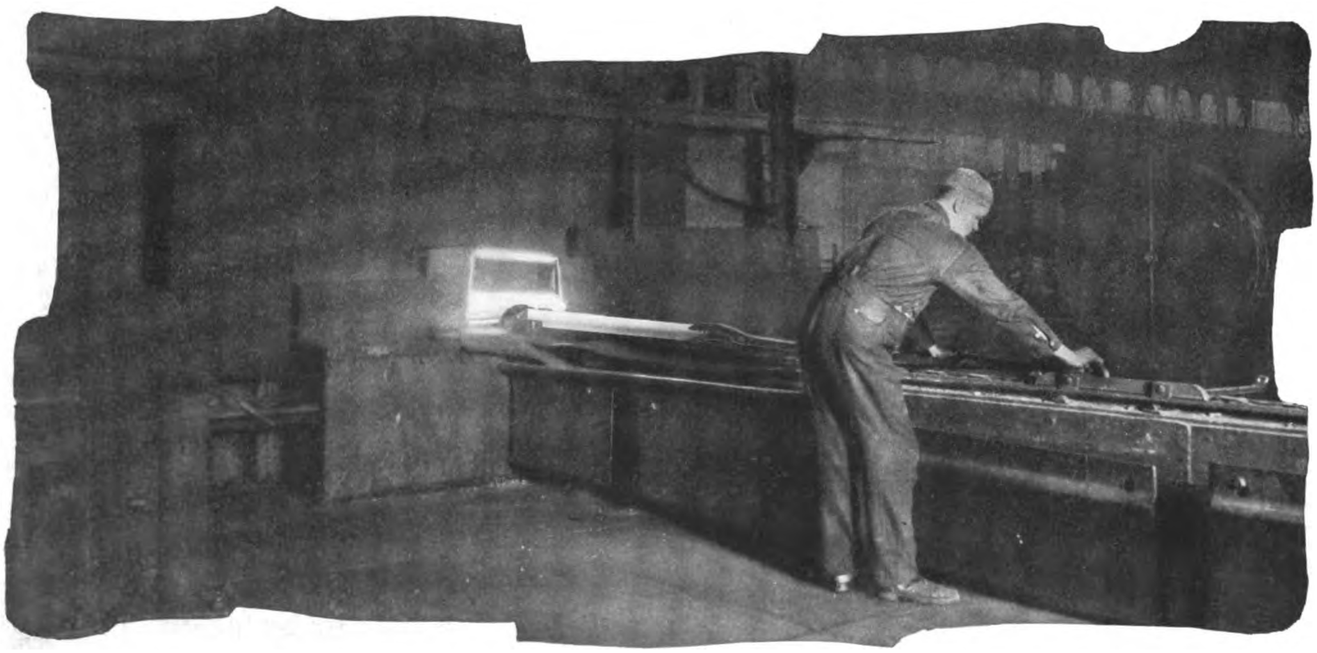
In making Double Extra Strong Pipe by this process, the pull required to draw the skelp through the bell is so great, on account of the thickness of the material, that it is necessary to weld a strong bar on the end of the skelp, to form a "bait" for the tongs, and thereby to distribute



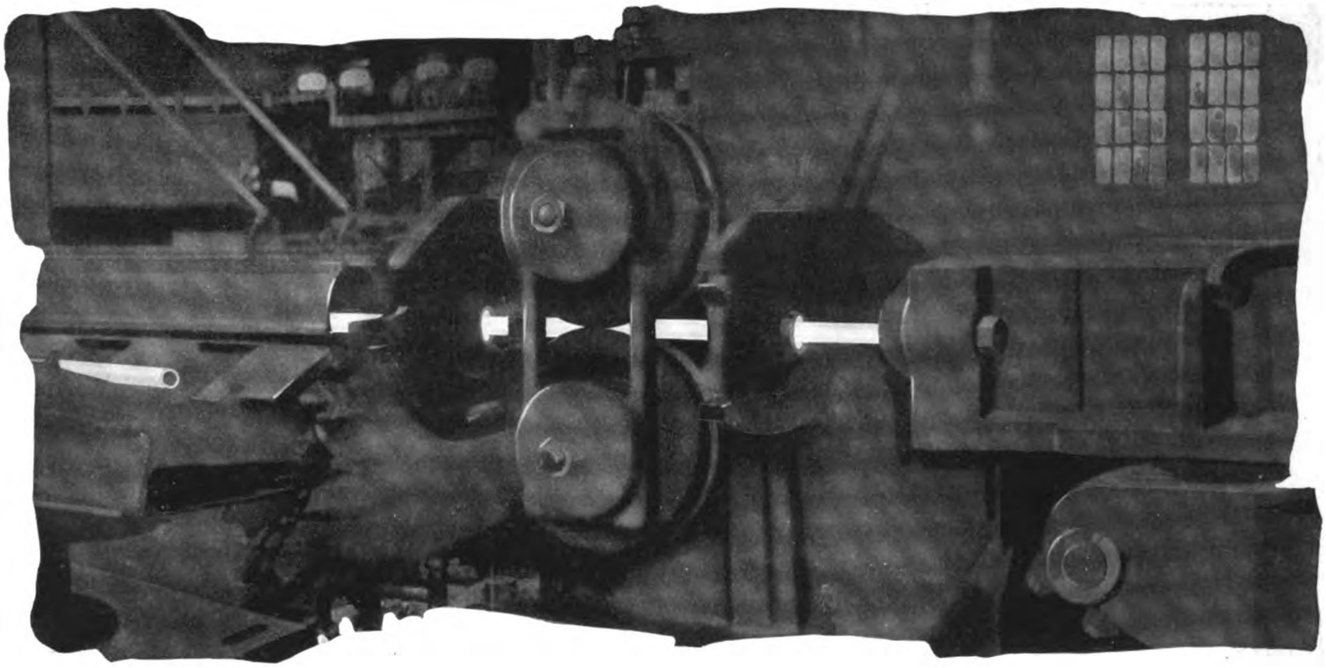
Charging butt-weld skelp into welding furnace



Detail view of welding die with skelp drawn through



Drawing and welding skelp into butt-weld pipe



Sizing rolls which give butt-weld pipe correct size and shape

more evenly the drawing strains, and to prevent tearing of the skelp by the tongs. With this bar attached, the skelp is drawn several times through bells of decreasing size, and is reheated between draws so that the seam will be thoroughly welded. It is evident that the skelp is put to a severe test in this operation, and if the metal were not sound and homogeneous, the ends of the pipe would be pulled off by the severe drawing strains.

Sizing Rolls

After the skelp has been welded into pipe by drawing through the die, it passes to a set of rolls, ordinarily known as sizing rolls, where it is reduced slightly in size,

Ends of butt-weld skelp trimmed and pressed to facilitate gripping by welding tongs

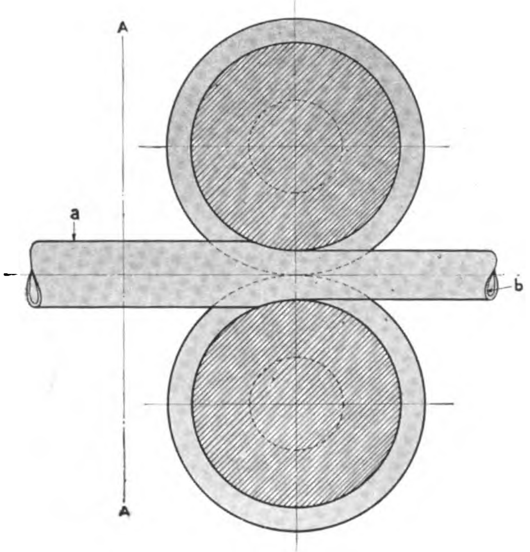


Fig. 11

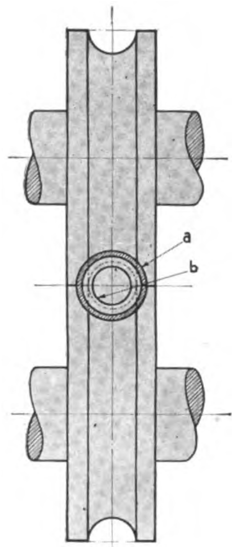
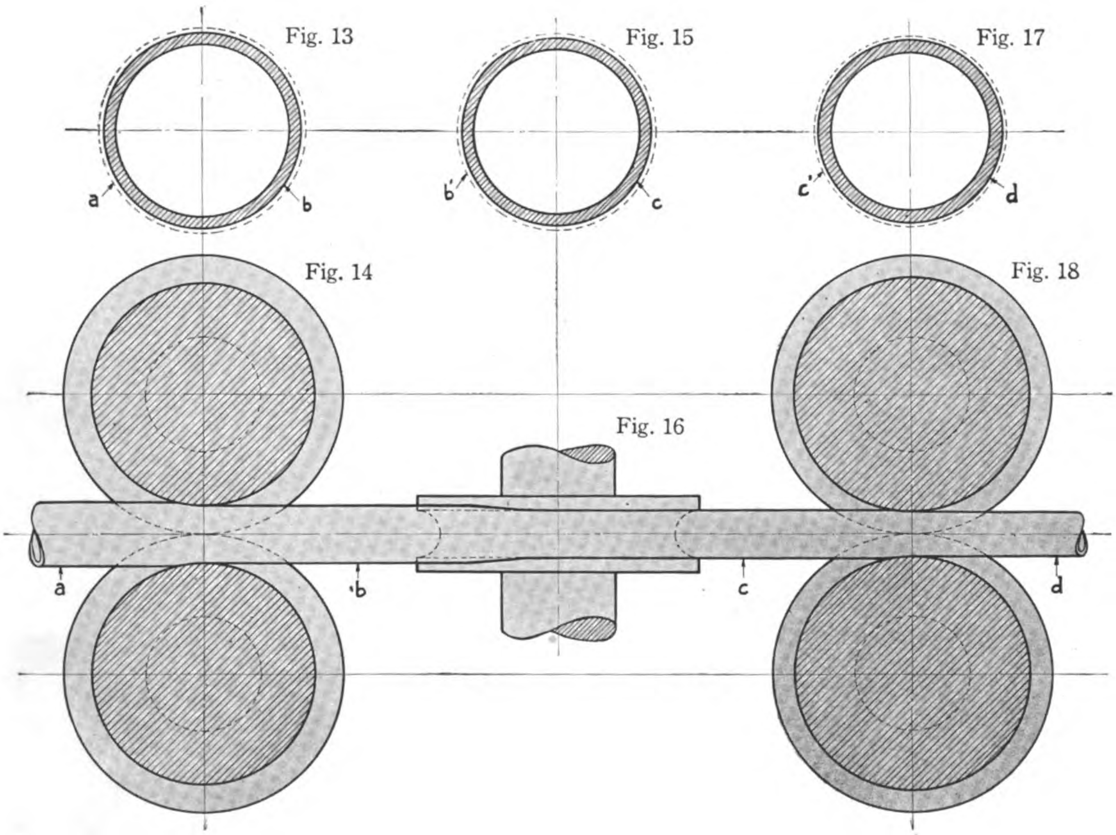
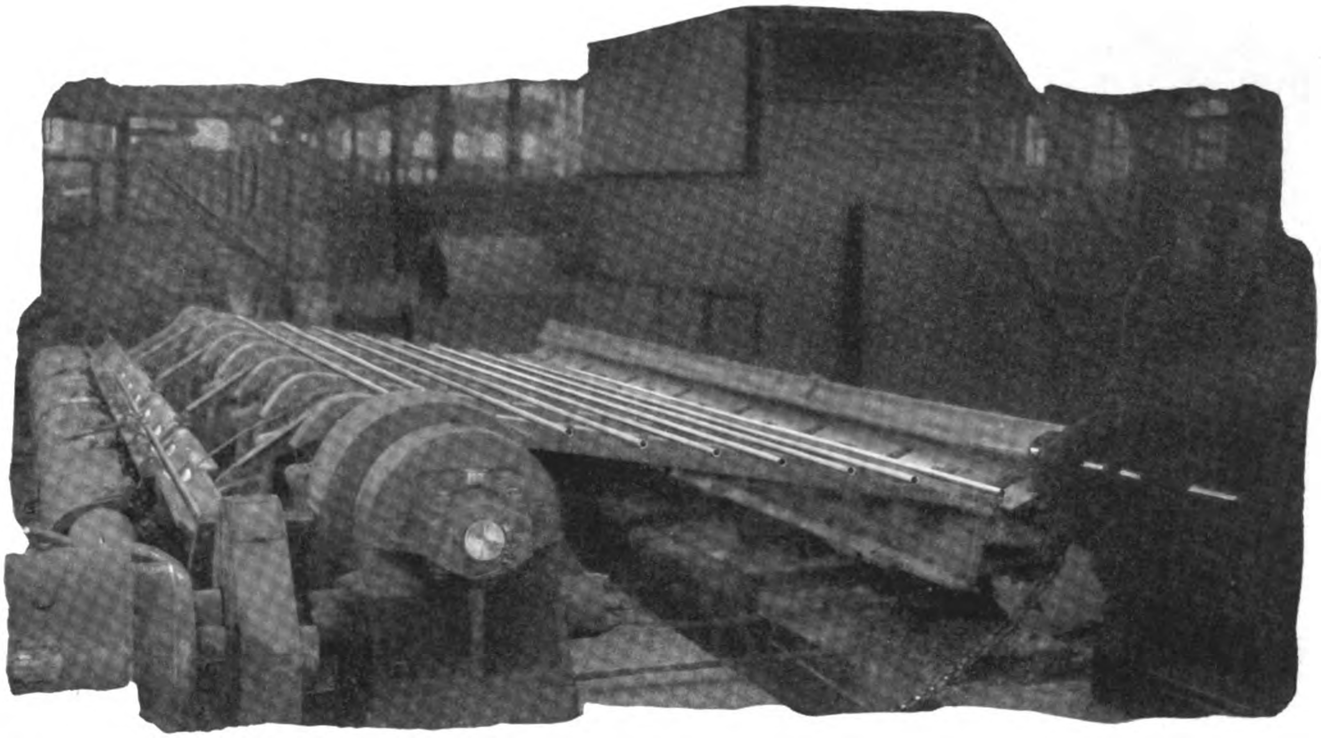


Fig. 12

Butt-weld sizing rolls (Figs. 11 and 12)

Scale-removing and finishing rolls for butt-weld pipe and diagram of results (Figs. 13 to 18)





Transfer table where pipe is reduced in temperature to facilitate removal of welding-scale

and elongated. In this operation, any heavy welding-scale which may have formed is partially loosened by the working of the rolls.

Cross Rolls

From the sizing rolls, the pipe is conveyed to a transfer table across which it travels to other rolls where it is reduced somewhat and slightly elongated, and then rolled to its correct finished size and circular contour. Any heavy mill scale, or welding-scale, which may be present is removed by this rolling operation, leaving the pipe walls smooth and clean.*

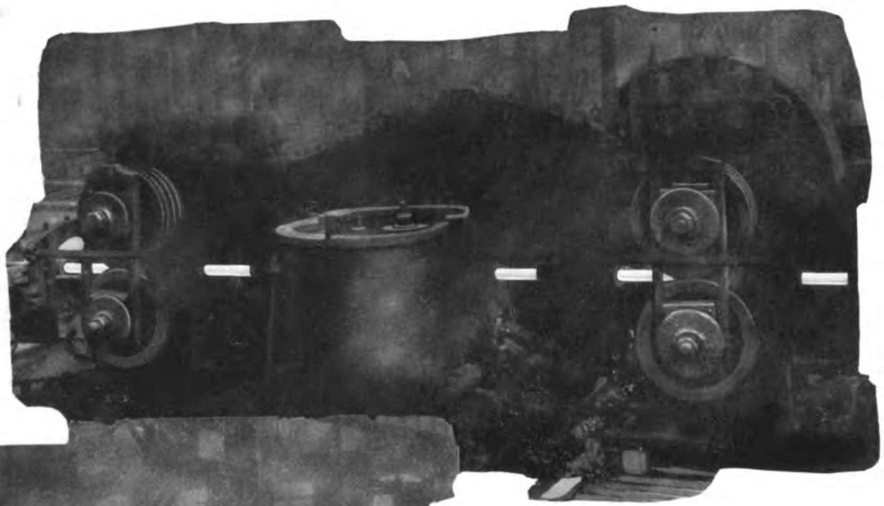
Straightening

When the pipe leaves the last stand of rolls, it is still at a high temperature, and as it is necessary to cool the pipe before subjecting it to further operations, a table is provided upon which the pipe passes and is slowly carried across. By the time the pipe has traveled from one end of the table to the other it is cool enough to pass through a set of cross rolls where any straightening that may be necessary is accomplished. The cross rolls also give added smoothness to the pipe surface.

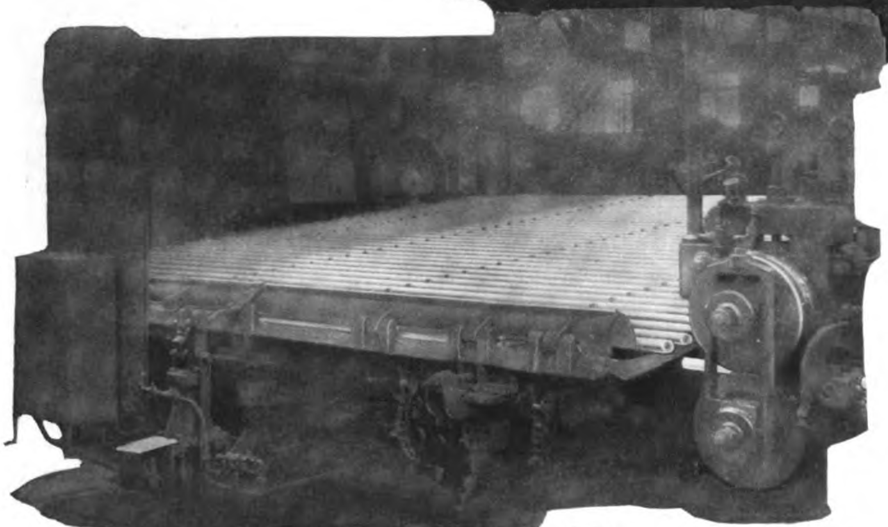
Washing Out Scale

From the cross rolls the pipe is picked up and conveyed by an electric crane to a tank where it is washed to remove the loosened scale and any foreign matter. This operation is quite necessary, especially when the pipe is to be galvanized or other protective coatings are to be applied. Certain sizes have the loose scale blown out by a blast of compressed air.

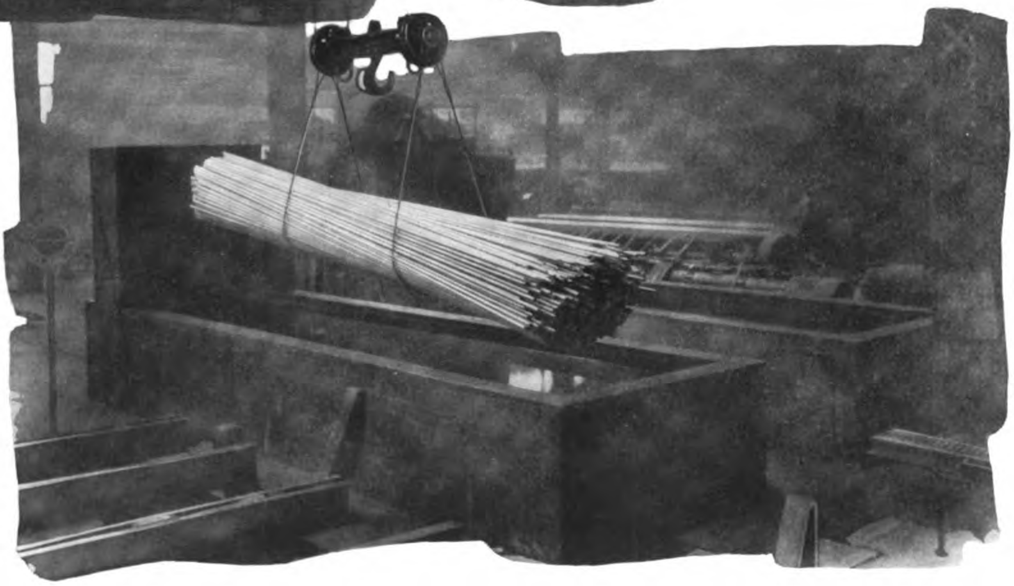
*See description of scale removing process, page 69.



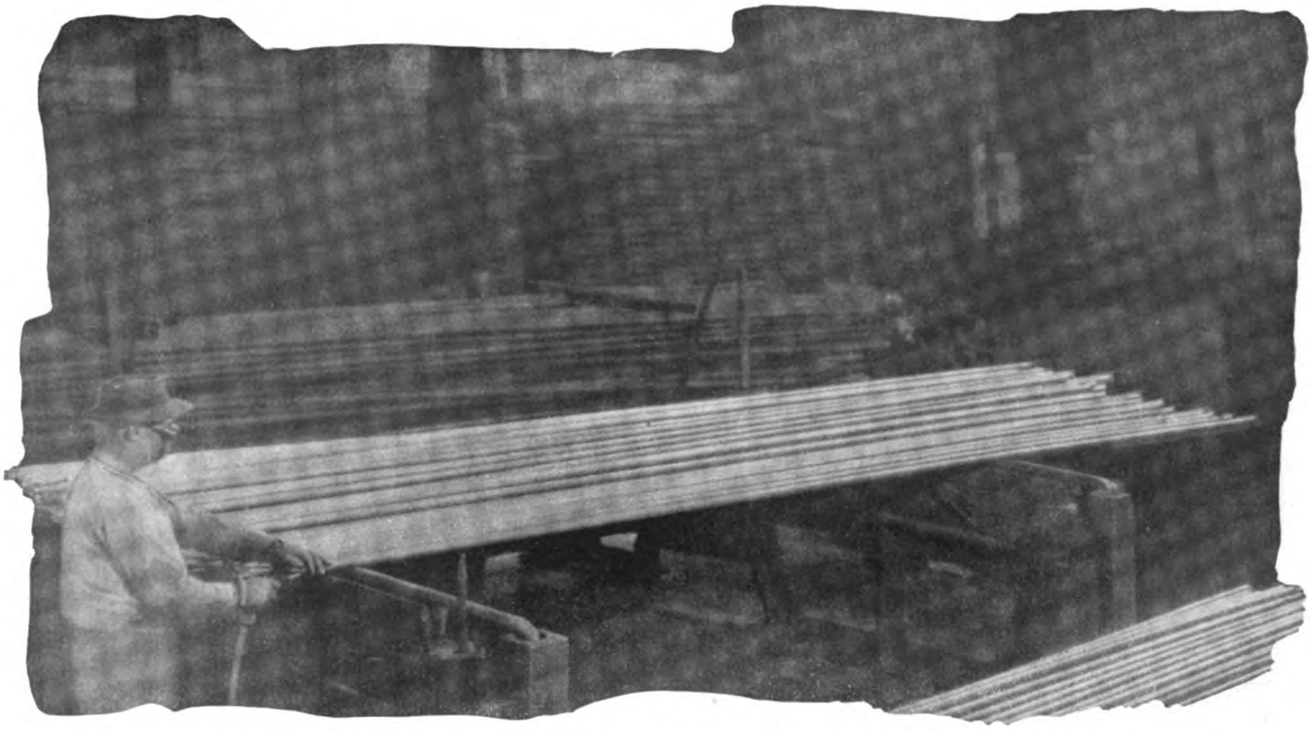
Series of rolls which remove the welding-scale and give the correct size and true circular shape



Cooling table on which pipe cools and straightens as it moves across



Washing the loose welding-scale from butt-weld pipe

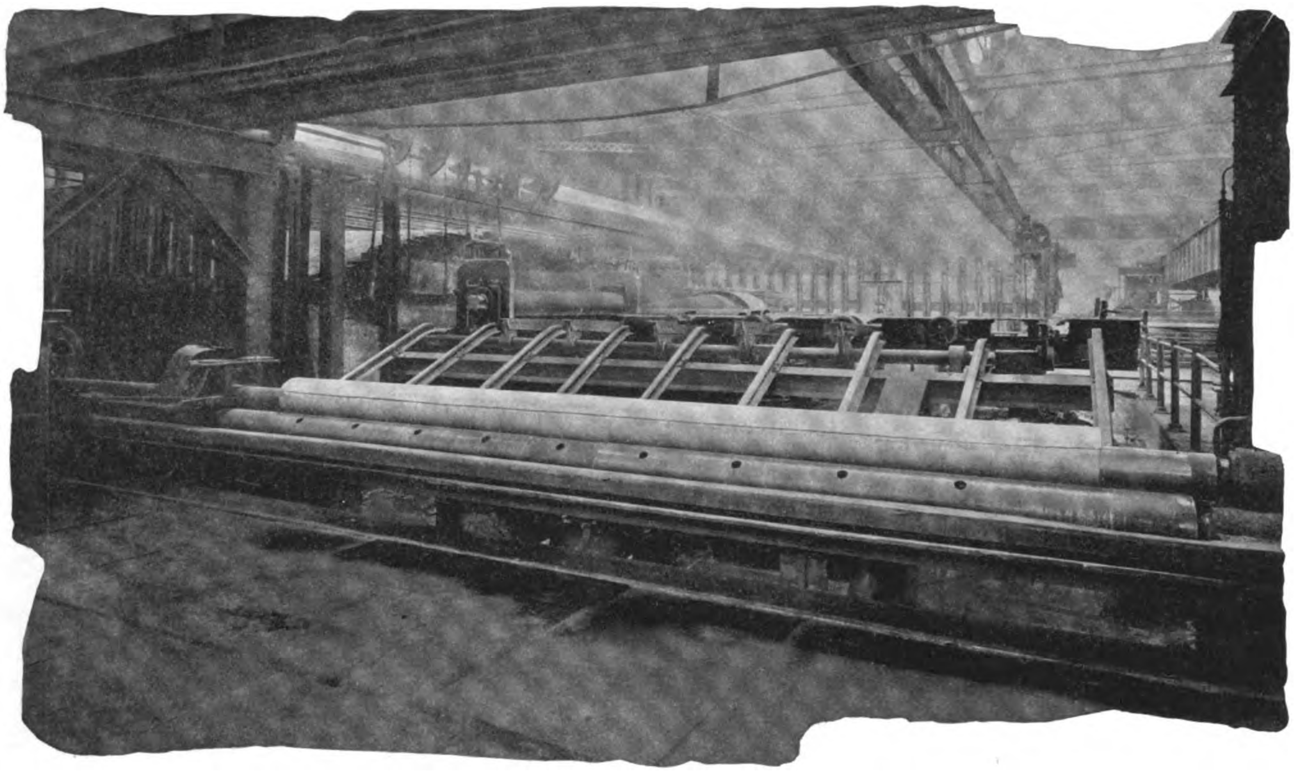


Blowing loose welding-scale from the smaller sizes of butt-weld pipe

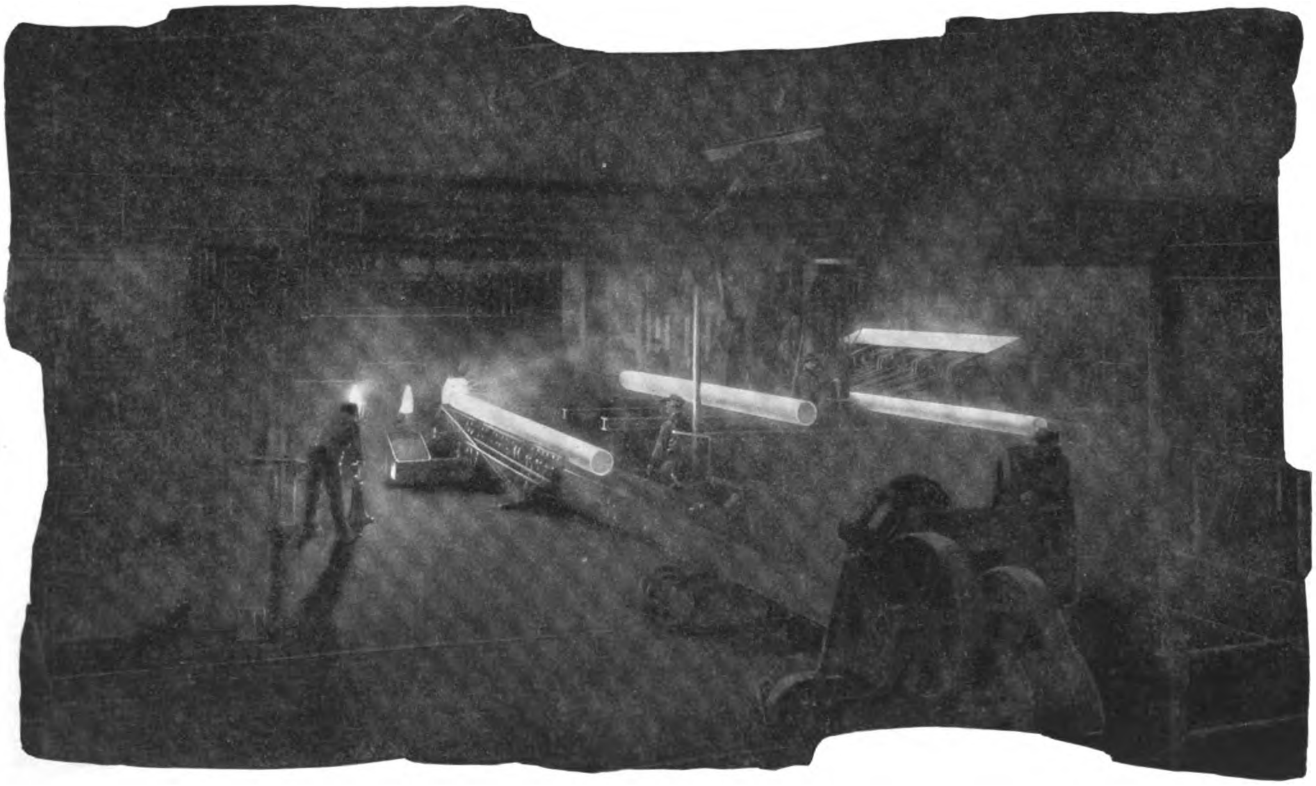
The ends of the pipe are then cut off for a short distance to remove the portions which have been crushed by the tong jaws in welding, after which the pipe is threaded and given an internal hydrostatic pressure test, to prove the soundness of wall and weld.

Hydrostatic Pressure Test of Butt-weld Pipe

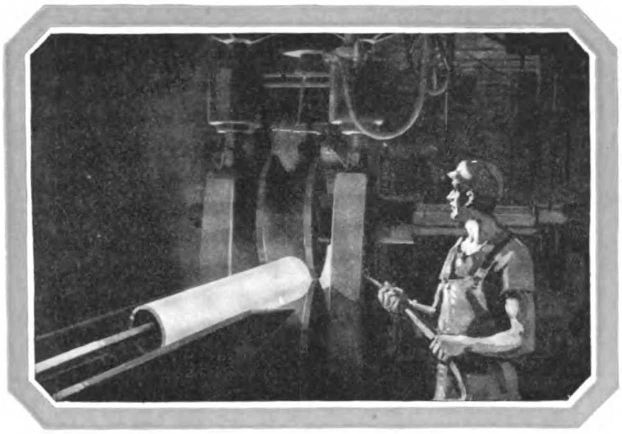
The internal hydrostatic pressure employed in testing "NATIONAL" butt-weld pipe varies from 700 to 800 pounds per square inch, and the test pressure in all cases is sufficiently beyond the actual service pressure to provide a substantial factor of safety and dependability.



Bending plates into cylindrical shape to form large size lap-weld pipe



Charging bent plates (skelp) into furnace where they are reheated for welding



Lap-weld Process of Making "NATIONAL" Pipe

(Employed for sizes 3 to 30-inch, inclusive)

WHILE either the butt-weld or the lap-weld process may be used in the manufacture of "NATIONAL" Pipe in sizes 1¼ to 3-inch inclusive, practically all pipe in these sizes is made by the butt-weld process, and pipe over 3 inches in diameter is made by the lap-weld process.

The lap-weld process is so named because the edges of the plates or skelp are overlapped and welded in this position, in contrast to the butt-weld process wherein the square edges of the skelp are butted together in a weld. (See diagrams, Figs. 19 and 20, below.)

Bending Plate or Skelp, Preparatory to Welding

The first step in making a pipe or tube by the lap-weld process consists of bending a plate or piece of skelp into rough tubular form, the edges of the plate having first been suitably scarfed, or beveled, to permit overlapping without undue thickness when welded. The bending operation is accomplished by heating the plate in a long furnace (called the bending furnace) and then passing the plate through triple rolls similar to those used for bending boiler and other heavy plate (if a large pipe is to

Diagrams illustrating difference between butt-welding (Fig. 19) and lap-welding (Fig. 20)

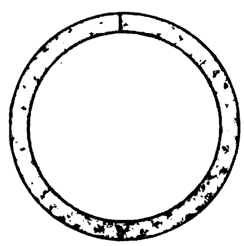


Fig. 19

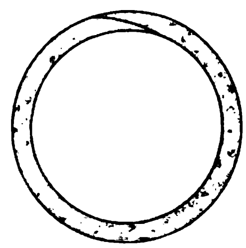
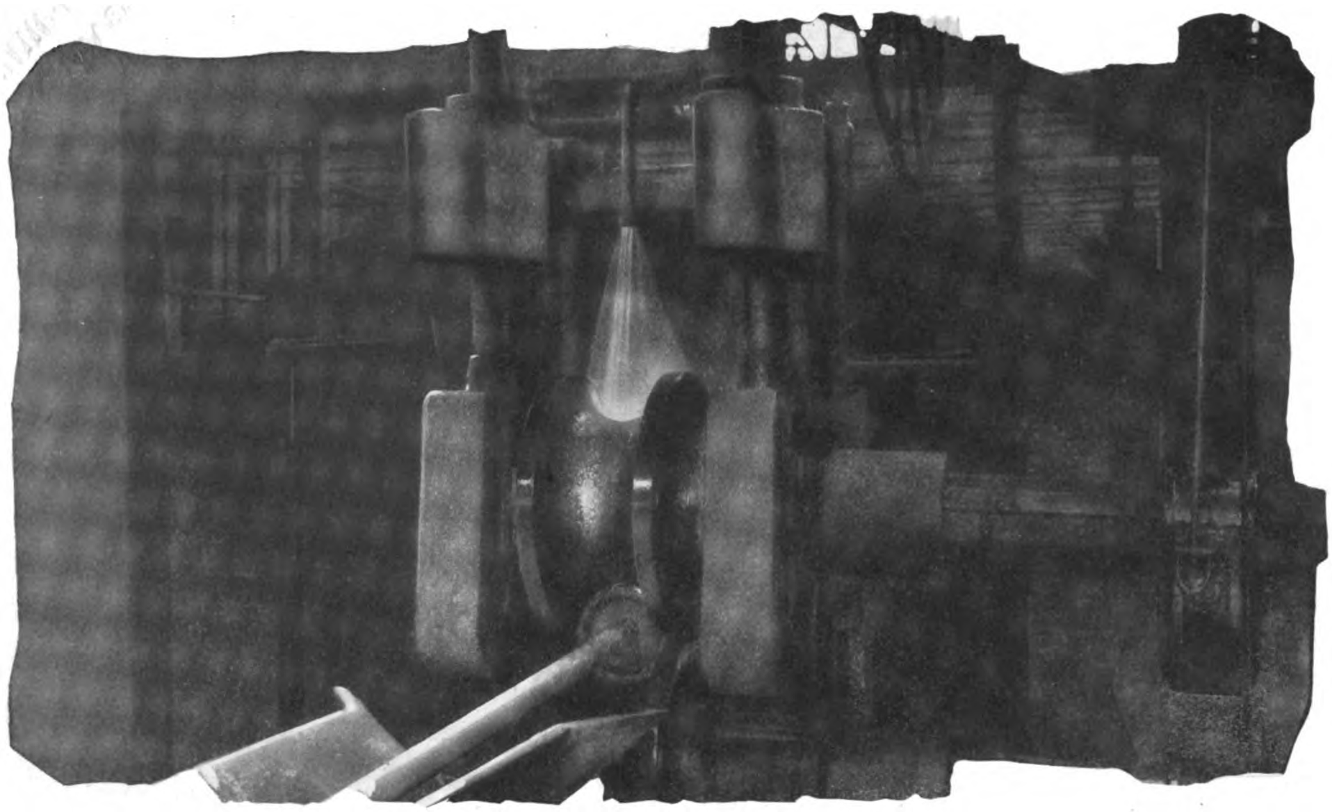


Fig. 20



Lap-welding rolls, showing mandrel in position

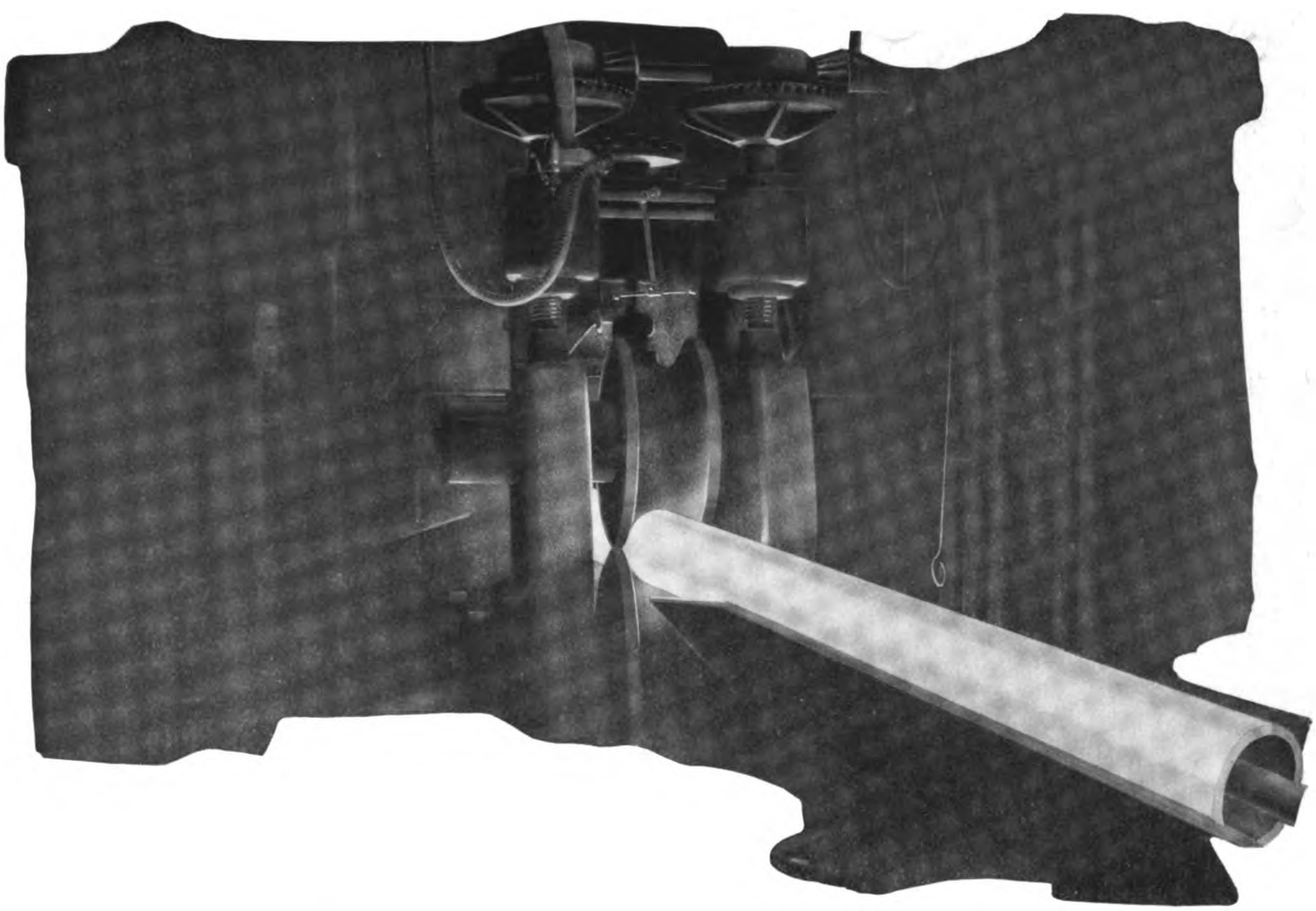
be made), or through a bending die which functions somewhat on the principle of a butt-welding die (if smaller sizes of pipe are to be made). The bending operation, in either case, results in a rough tube with the longitudinal beveled edges overlapping, and at this stage of manufacture it is placed in another furnace, called the welding furnace, where it is reheated to welding temperature.

When it has reached a suitable temperature it is removed from the furnace and passed between two revolving rolls so grooved as to form an opening between them that is approximately the same size as the finished pipe. In this opening, there is held a bullet-shaped mandrel approximately the same size as the inside diameter of the pipe, and the bent skelp passes between this mandrel and the rolls. The overlapping edges of the skelp are forcibly pressed together between the rolls and against the mandrel (which acts as an anvil), and are thereby thoroughly welded. (See illustrations.)

Welding Furnace and Lap-welding Rolls

Sizing, Straightening and Finishing Operations

After the pipe comes from the welding rolls it is inspected and, to give it the correct diameter, passed through a set of sizing rolls, and then travels to cylindrically-shaped cross-rolls where the tube is straightened and rounded up to true circular shape. It then passes to a slightly inclined table where it slowly cools as it passes along.



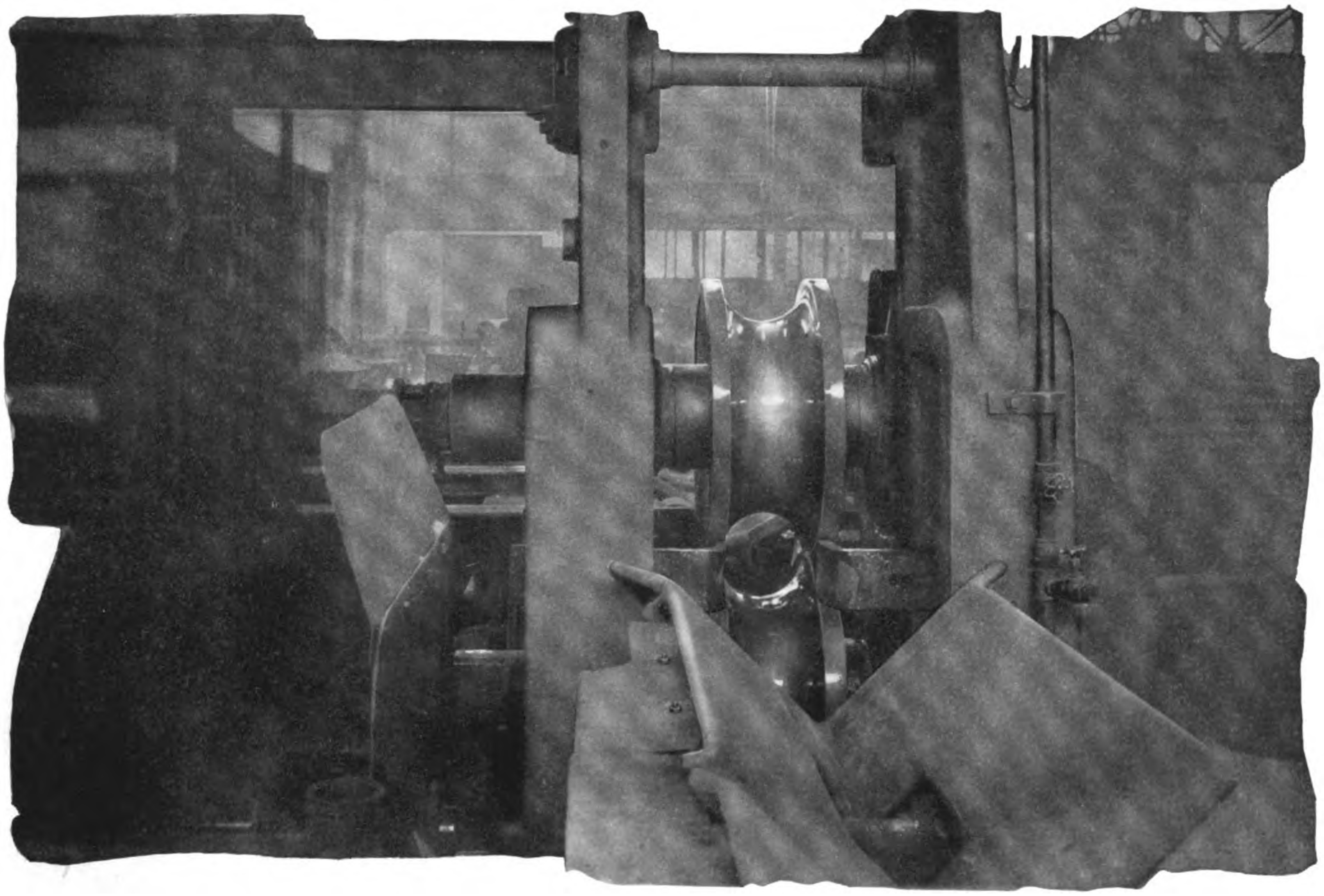
Pipe coming through lap-welding rolls over mandrel

In the case of some sizes of Double Extra Strong Pipe (3-inch to 8-inch) made by the lap-weld process, two pipes are first made in sizes which will telescope, the respective welds being placed diametrically opposite each other when the pipes are telescoped. The telescoped pipes are then returned to the furnace, brought to the proper welding heat, and given a pass through the welding rolls. A pipe made in this way is as strong as, or stronger, in respect to its resistance to internal pressure, than pipe made from one piece of skelp, as each individual pipe is thoroughly welded at the seam before telescoping and re-rolling them together.

Welding Double Extra Strong Lap-weld Pipe

As in the case of butt-weld pipe, the ends of lap-weld pipe are more or less mutilated in manufacture, and it is necessary to trim these ends off before the pipe can be threaded. In certain instances, these crop ends are used for testing purposes. The test usually applied to the crop ends of line pipe consists of flattening the ring of metal between parallel flat plates until the distance between the plates is about one-third of the pipe diameter with the weld 45 degrees from the point of maximum bend. When pipe is specified for bending and

Physical Tests



Sizing rolls which give lap-weld pipe correct size

Cross-rolls which straighten lap-weld pipe and give true circular shape

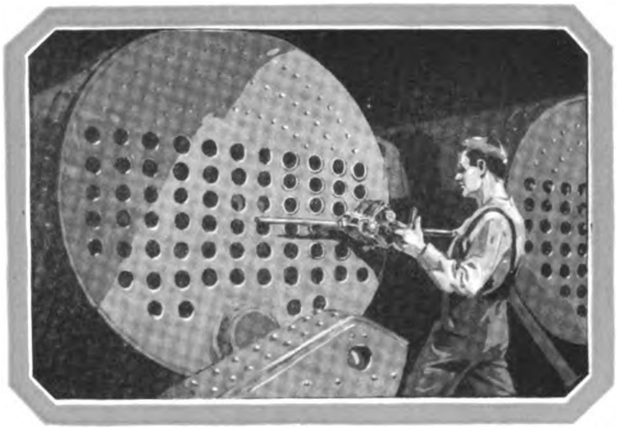
Cooling table for lap-weld pipe

flanging purposes the test specimen is flattened to about one-fourth of the diameter.

Hydrostatic Pressure Test of Lap-weld Pipe

When the ends of the pipe have been trued up, and a coupling screwed upon one end, it is placed between two water-tight heads of a hydrostatic testing machine and subjected to an internal hydrostatic pressure of 600 to 3,000 pounds per square inch, according to the size and weight of the pipe.

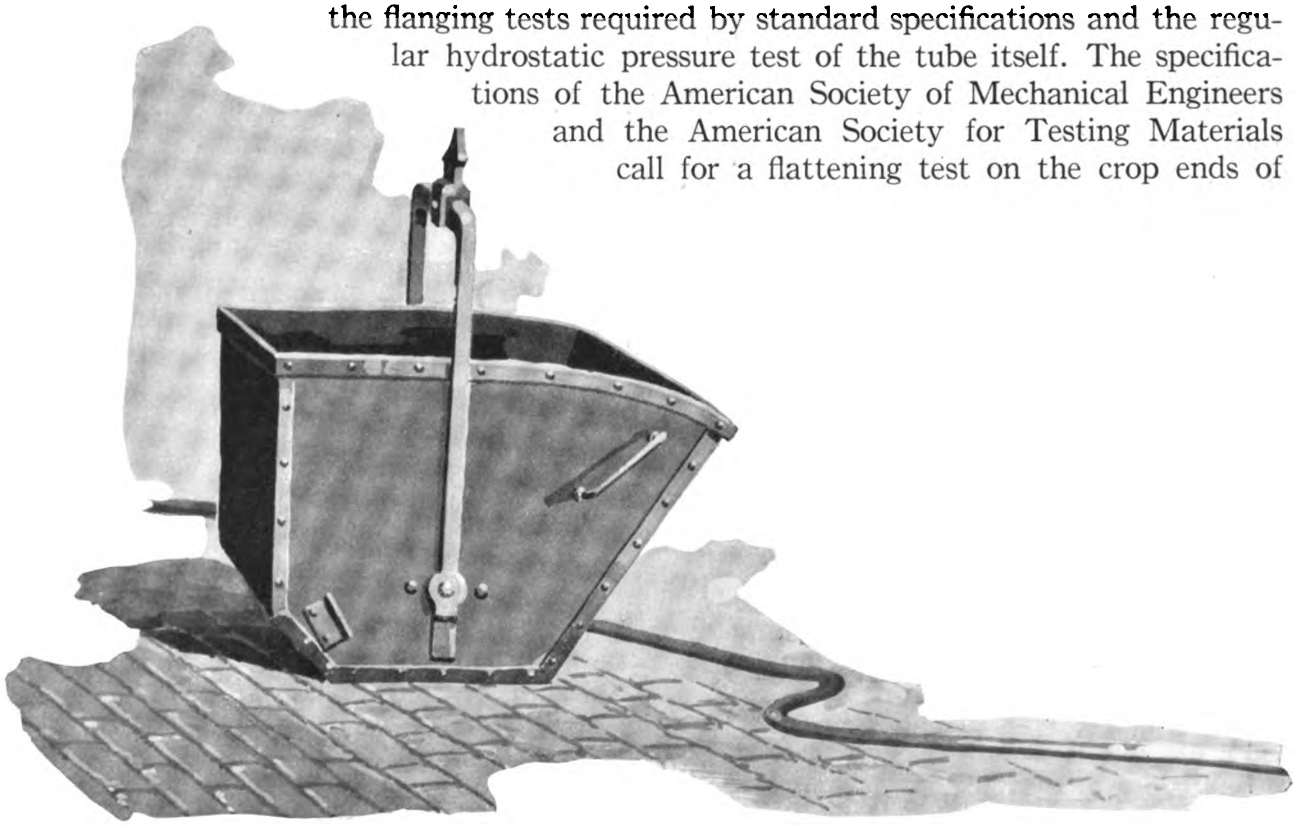
Inspecting and cutting off rough ends of boiler tubes

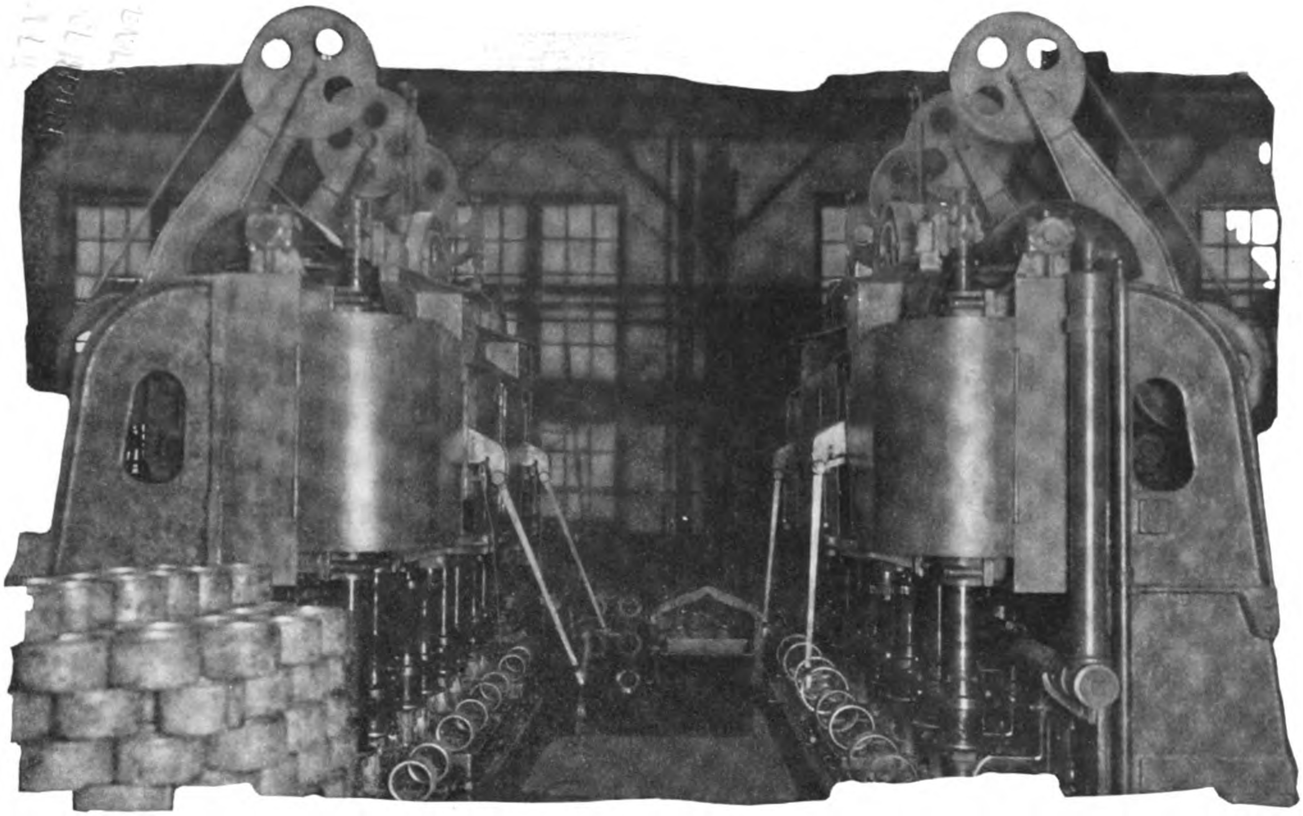


Manufacture of Lap-welded Boiler Tubes

THE operations used in the manufacture of lap-welded boiler tubes are identical with those used in the manufacture of lap-welded pipe. However, only open hearth steel is used for "NATIONAL" Modern Welded Boiler Tubes, and the tests given are much more severe than those given to pipe. For example: Both crop ends from each "NATIONAL" Lap-welded Boiler Tube are given a flattening test, in addition to the flanging tests required by standard specifications and the regular hydrostatic pressure test of the tube itself. The specifications of the American Society of Mechanical Engineers and the American Society for Testing Materials call for a flattening test on the crop ends of

Flattening and Flanging Tests





Tapping pipe couplings

but two tubes in each lot of 250 or less, but National Tube Company continues this test to include every "NATIONAL" Lap-welded Boiler Tube manufactured. The flattening and flanging tests are very near to actual tests of the tube itself, as they are made on portions of the tube immediately contiguous to the flue sheet ends of the finished product. A large factor of safety and dependability is thus provided to meet the unusual demands often forced upon a boiler tube in service. There is perhaps no other class of tubular material which receives greater care and attention in manufacture, inspection and testing than boiler tubes, and likewise there is perhaps no other class of tubular material upon which the safety of life and limb is more dependent.

Hydrostatic Pressure Test of Boiler Tubes

All boiler tubes are tested by internal hydrostatic pressure, varying from 500 to 1,000 pounds per square inch, according to the size of the tube and the fibre stress of the material of certain sizes. The tubes while under pressure are struck with a two-pound steel hand hammer or its equivalent.

The tubes, after being tested, are stenciled with the name or brand of manufacturer, kind of material from which they are made and the test pressure employed in pounds per square inch.

Additional Manufacturing Operations

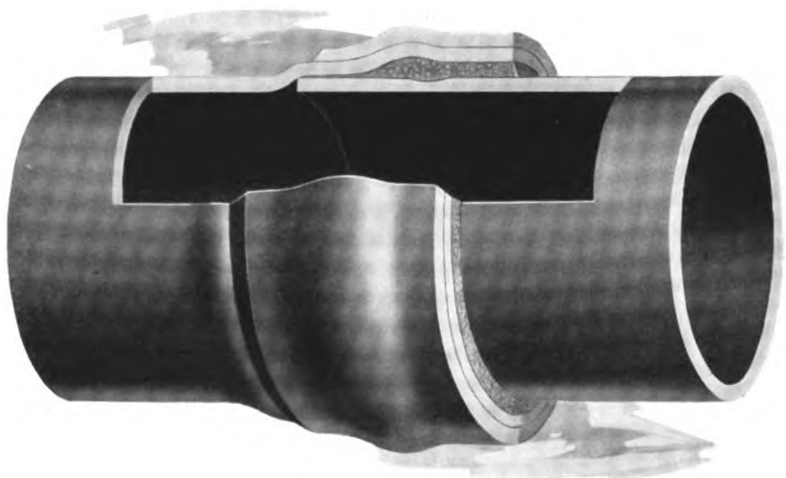
THE manufacturing processes described in the preceding chapters are common to "NATIONAL" Modern Welded tubular products in general, but it will be understood that these basic processes are supplemented or modified in the manufacture of special types of wrought tubular products.

For example, special types of pipe and casing are made for unusual conditions encountered in drilling oil and gas wells, and their manufacture requires extra operations, such as upsetting to strengthen the joint by increasing the wall-thickness at the point of greatest strain, and special threading to insure accurate alignment and dependability of the string in a well.

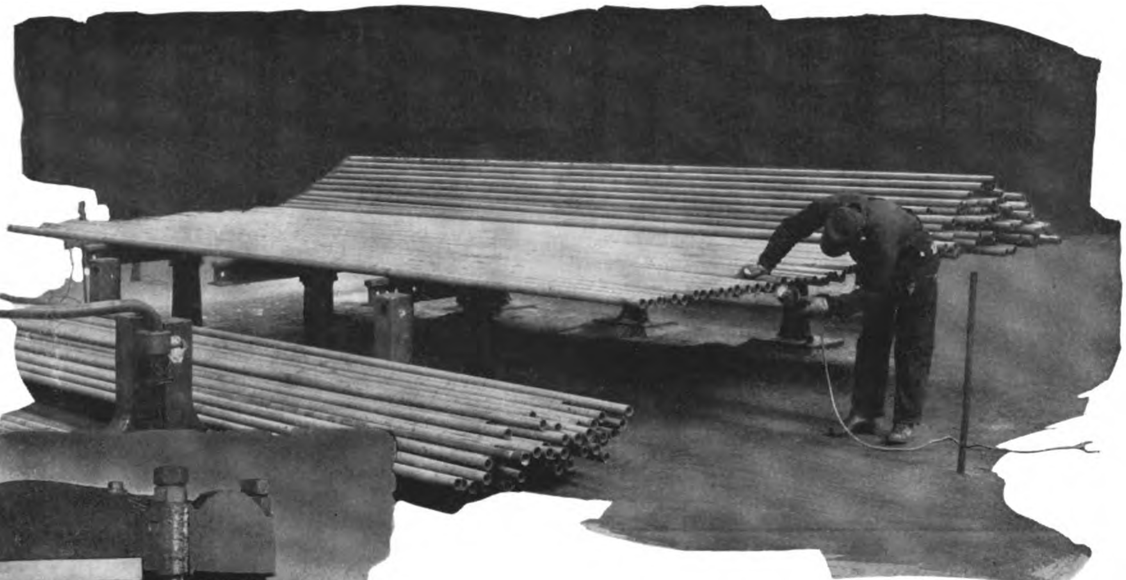
Special Operations on Casing

Or, the pipe may be expanded, as in the case of the "NATIONAL" Matheson Joint (see illustration), where the end of the pipe is heated and "belled" out to form a socket for the insertion of the spigot end of another pipe.

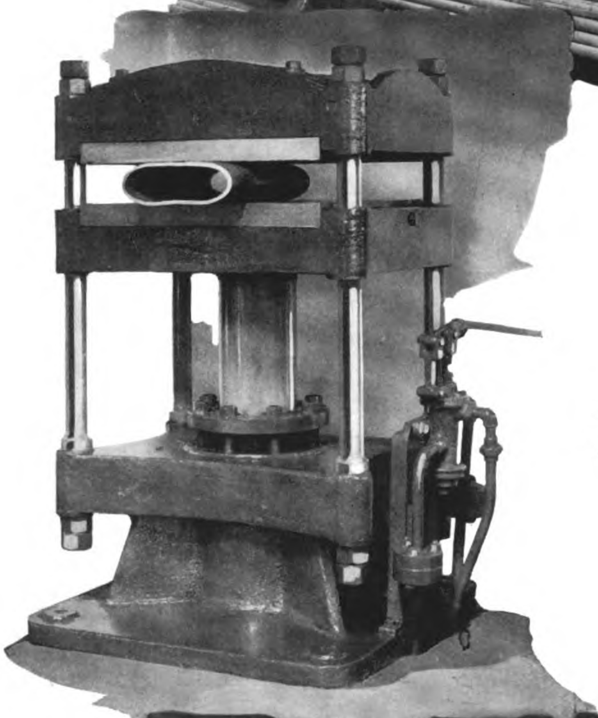
Matheson Joint



Sectional view of the Matheson joint



Inspecting each length of pipe



Special flattening test

Internal hydrostatic pressure test

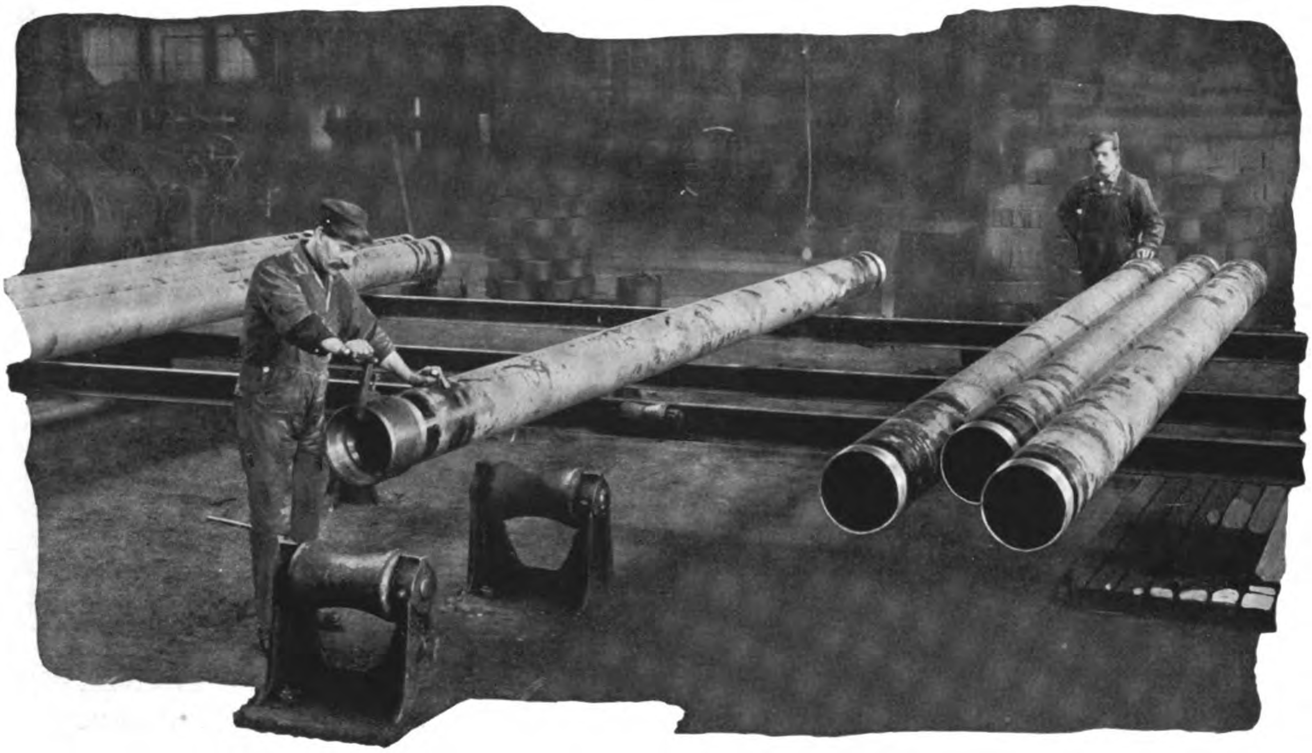
The Inspections and Tests of "NATIONAL" Pipe

STANDARD tests for various materials used in engineering fields have been devised and advocated by influential associations and societies throughout the country, and the consumer has usually been content to accept the adequacy of such tests. Although National Tube Company is acquiescent in the view that the standard tests are severe enough to take care of most service requirements, still, to make certainty an invariable policy, it is the practice to amplify these tests in special instances so that, instead of a certain number from a lot, each and every length of tube or pipe is included.

Policy in Regard to Tests

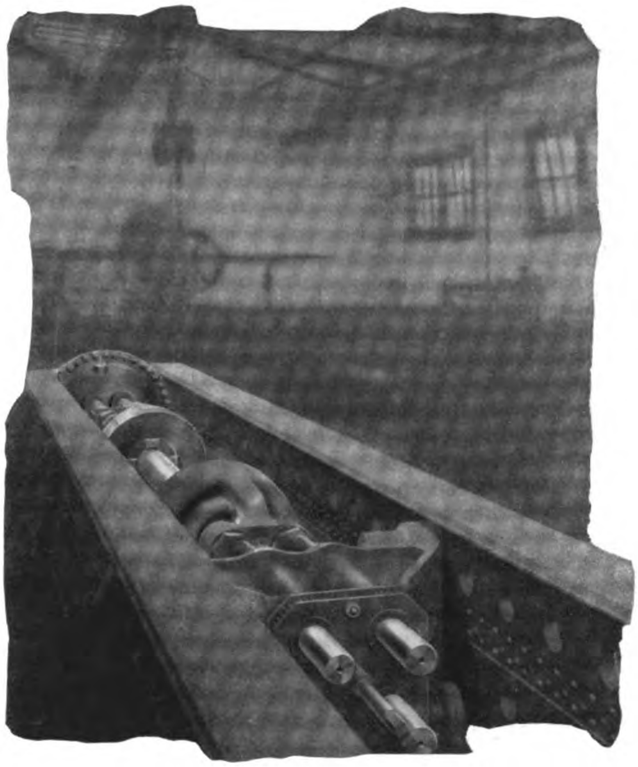
While great care is employed in connection with the modern processes, and high grade raw materials are used in the manufacture of "NATIONAL" tubular products, resulting in a high factor of reliability, the tendency of National Tube Company is to make tests more rigid from time to time than actual requirements demand. Conditions of service and operation, while usually known and provided for, are sometimes affected by unknown causes, and disastrous results are many times avoided by making assurance doubly sure.

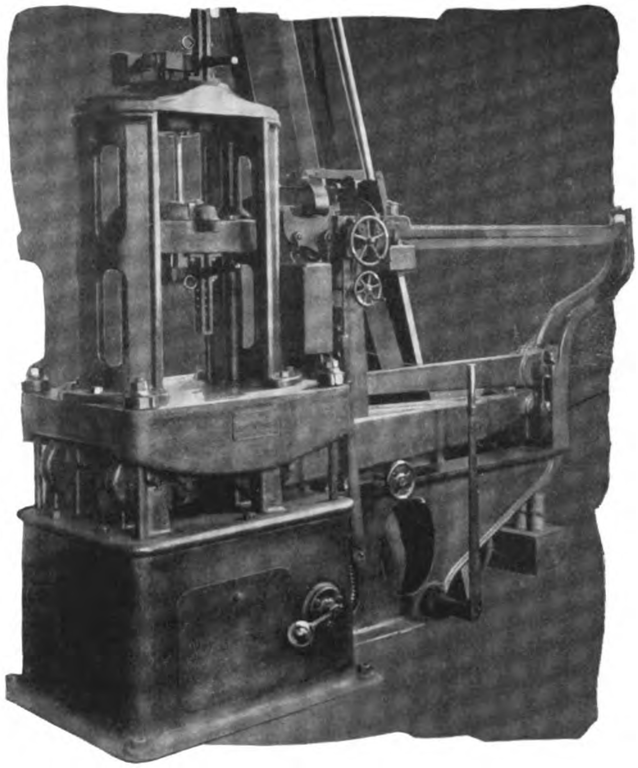
Inspecting threads of large size pipe



Gauging threads on large size pipe

Testing, measuring and bundling small size pipe





Tensile testing, or pulling, machine for special tests on large size pipe and joints

Tensile testing machine for determining the physical properties of pipe steel

Tested from Ore to Finished Pipe

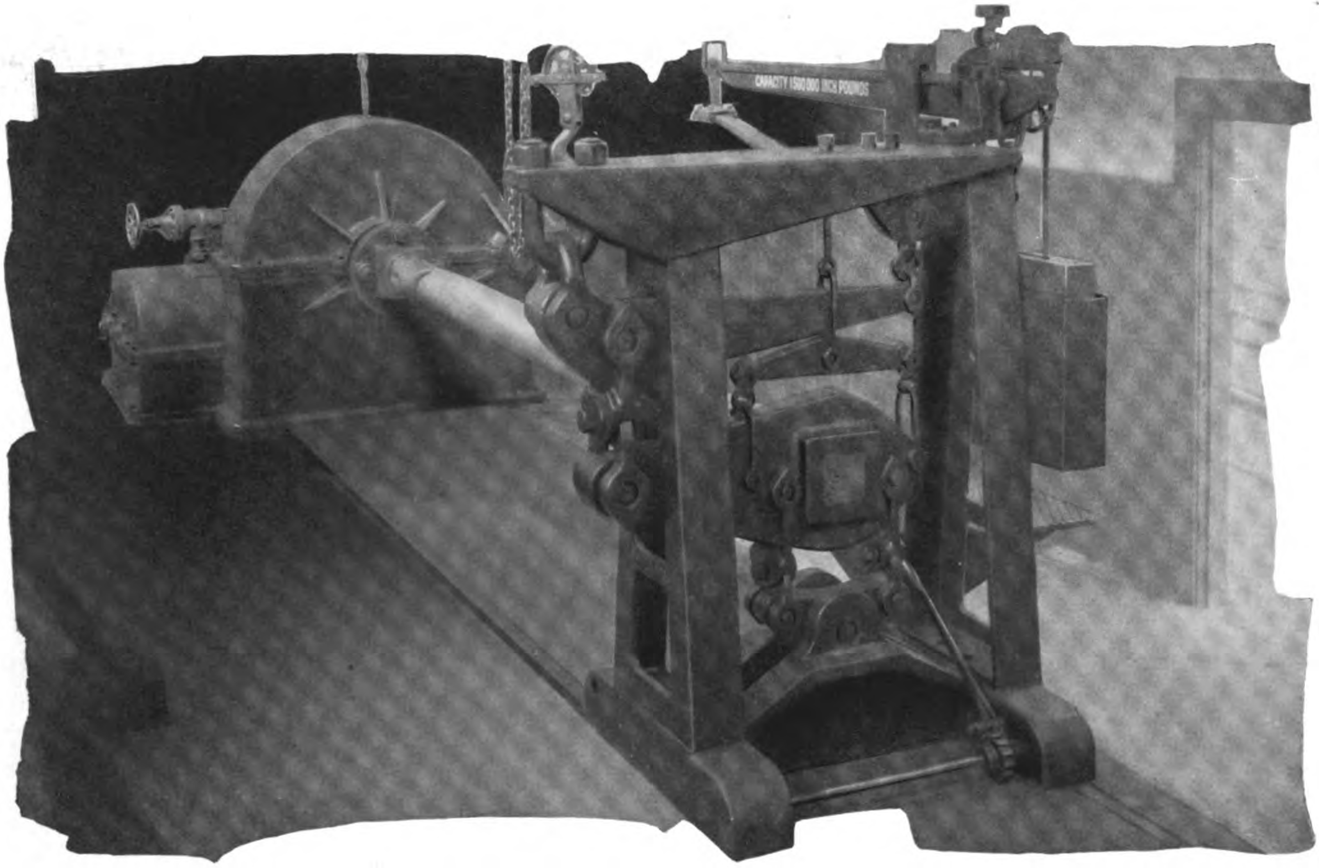
From the time the crude ore is put into the blast furnace until "NATIONAL" Pipe is ready for the hydraulic test, the results on the material of each successive process are carefully inspected and, as a consequence, at the final hydraulic test, the failures are remarkably few.

Every piece of "NATIONAL" Pipe is inspected for surface defects, and must stand the internal hydrostatic pressure test without leaks.

Hydraulic testing machines are located at convenient places throughout the mill, and are so arranged that the pipe can be adjusted between two water-tight heads connected with the hydraulic line. The test pressure varies from 450 to 3,000 lbs. per square inch, according to the size of pipe and the service for which it is intended.

Flattening Test on Lap-weld Pipe

In addition to the hydraulic test and in order to keep a check on the manufacturing processes, the crop ends of each length of certain classes of lap-weld pipe are subjected to a flattening test. In this test a crop end, 4 inches or longer, is flattened between parallel plates until the distance between the plates is one-third the outside diameter of the pipe. In making this test the weld must be 45 degrees from the point of maximum bend. Should the crop end show cracks or open at the weld upon being so tested, the



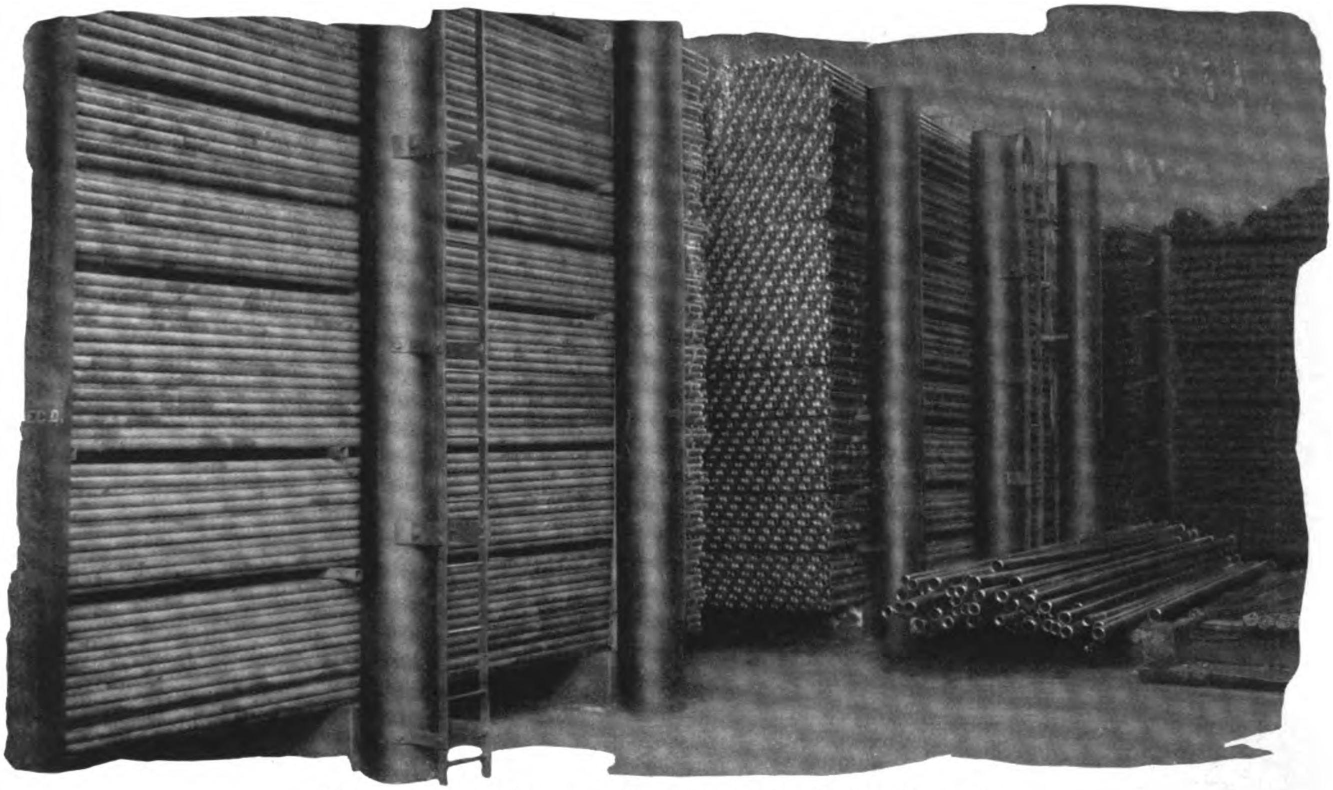
Torsional testing machine for determining the physical properties of pipe under twisting forces

other crop end is tested, and should this also show such defects, the length of pipe from which the tested ends were cut is scrapped.

Special Tests for Special Purposes

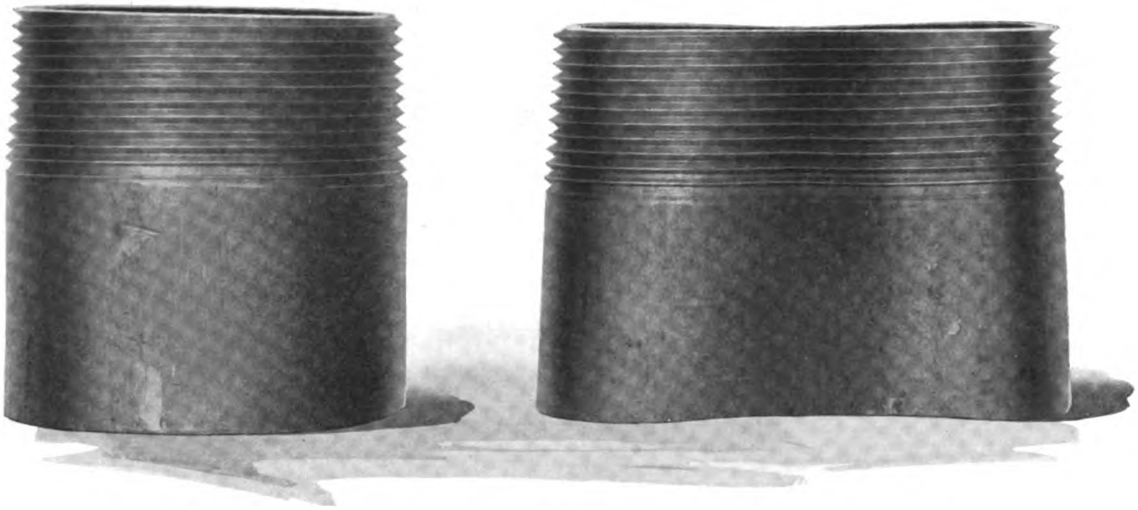
Along similar lines "NATIONAL" tubular products are tested to determine the tensile strength and elastic limit; and further special tests are made on tubes intended for special purposes. These special tests vary with the ultimate use of the product, as for instance, "NATIONAL" Pipe for Ammonia Lines, which is tested under water.

While the consumer has usually been content to accept the adequacy of standard tests of the various technical and mechanical societies and associations throughout the country, certain conditions exist which would seem to require special attention and treatment; for instance, a blanket specification in which is set forth certain tests of a material may not cover specific applications in the light of some engineers' conceptions of a problem—hence, the tests must be amplified by the manufacturer's own initiative. When this is done, the consumer is assured of pipe which is sound, through and through—tested beyond the requirements of ordinary service, and a thoroughly dependable material.

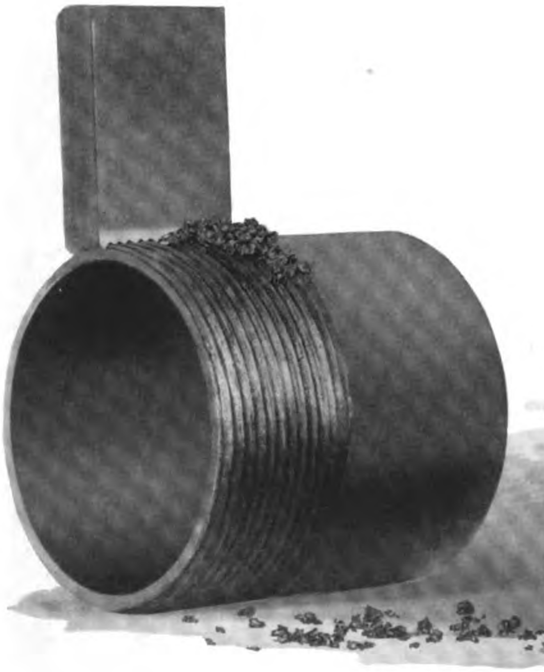


Section of stockroom, showing method of piling pipe

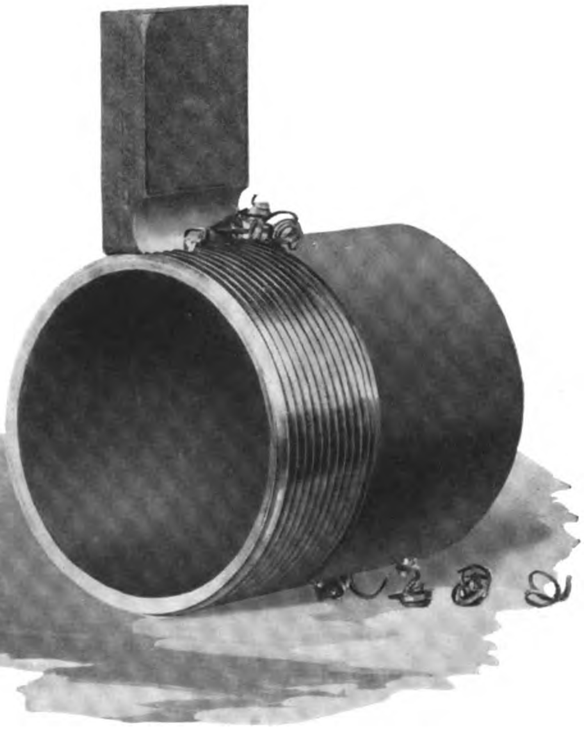
A carload ready for shipment



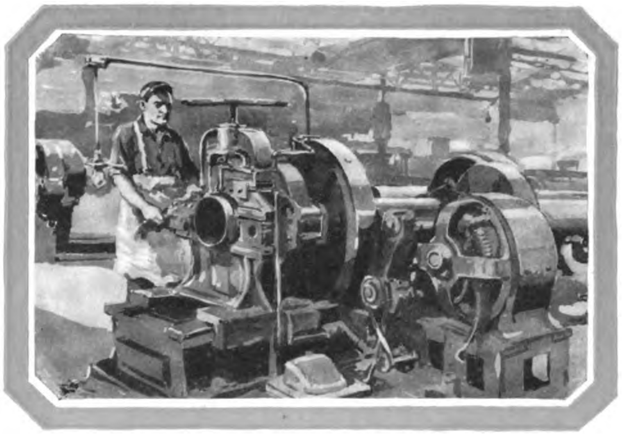
Properly designed dies and uniform metal result in good, strong threads. Note the threads on this specimen, which remained intact when the pipe was crushed wall to wall



Rough threads cut with improperly designed die. Note crumbling chips



Clean, smooth threads cut with properly designed die. Note spiral chips



Correct Threading Principles

THE clean-cut, strong threads which are obtained on "NATIONAL" Modern Welded Pipe are due to the uniformity of the mild steel used, absence of laminations caused by slag streaks, blisters, pockets, etc., and lack of cinder or other foreign matter. This steel, being homogeneous, cuts clean, and maintains its characteristic strength in the lightest part of the smallest thread. The left hand upper view on page 64, shows threads cut on "NATIONAL" Modern Welded Pipe. These threads remained intact even after being subjected to the flattening test used to demonstrate the ductility and uniformity of the material, as shown in the right hand view.

Uniform Material Necessary for Good Threads

It is highly important that threading dies be kept in good working condition, for even with uniform pipe it is difficult to secure good threads if the chasers of a die are lacking in proper lip angle, clearance in lead or throat, have broken teeth, or if the die is lacking in chip space, sufficient number of chasers, etc.

Importance of Good Dies

For cutting threads on regular Bessemer steel pipe, each chaser should have a lip angle of 15 to 20 degrees, as shown in Fig. 21, page 66; for Open Hearth, at least 25 degrees, as shown in Fig. 22. By grinding a slightly curved lip of this angle, an easy cutting action is given to the chaser, similar to that of a properly ground lathe tool, and the effect of pushing the metal off instead of cutting it is avoided (see illustrations, page 64). If there is a square corner or shoulder at the top of the lip, this should be removed, as it forms a place where chips may lodge and pile up, resulting in torn threads and unnecessary friction and often in condemnation of the thread by the inspector in charge.

Correct Lip Angle

Clearance is the space between the pipe threads and the teeth of the chaser. It is necessary to have proper clearance to prevent the teeth of the chaser from

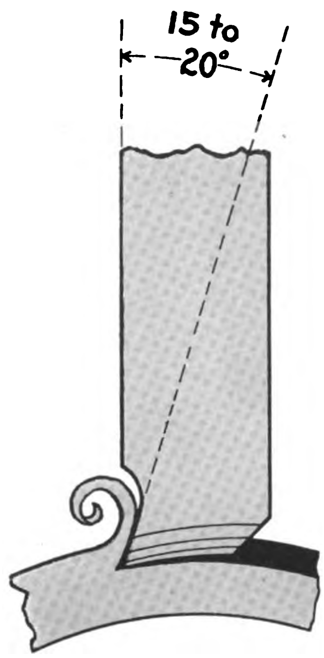


Fig. 21

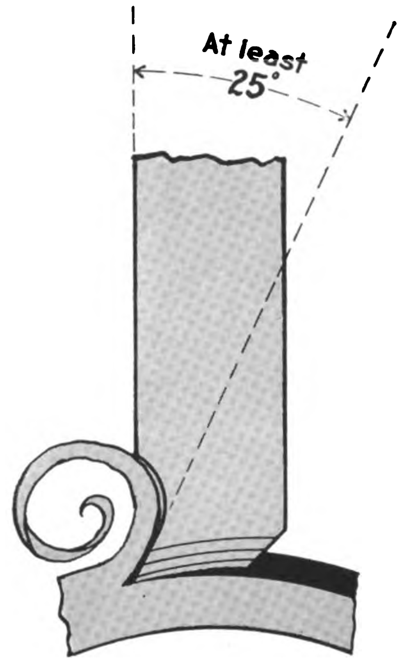


Fig. 22

dragging on the threads of the pipe and spoiling them, and to give an easy cutting action to the die. The clearance should be a little greater in the lead of a die than at any other place, as this is the point of heaviest duty, but it should not be excessive, as too great clearance will produce results as bad as if no clearance were allowed.

Proper Clearance Important

Lead is the angle which is machined or ground on the first three threads (more or less) of each chaser to enable the die to start on the pipe, and also to distribute the work of making the first cut over a number of threads. The lead may be machined on, or, as is more frequent, it may be ground on after the chasers are tempered. The proper amount of lead is about three threads. As the heaviest cutting is done by the lead it should have slightly greater clearance angle than the rest of the threads on the chaser, but care must be used to see that this angle is not excessive. Too much clearance here will cause the die to lead too fast, and the half threads cut by the lead are consequently damaged by the full teeth of the chasers.

Points Concerning Lead, or Throat

Good Threads Necessary for Sound Joints

The easy cutting and threading qualities of "NATIONAL" Modern Welded Pipe* make it an ideal material for railing and guard construction where a considerable number of short and bent lengths are used. There are no hard streaks, pockets or laminations to retard the work of cutting tools or threading dies. The result is sound, neat joints.

*See "NATIONAL" Bulletin No. 6—"Correct Pipe Threading Principles."

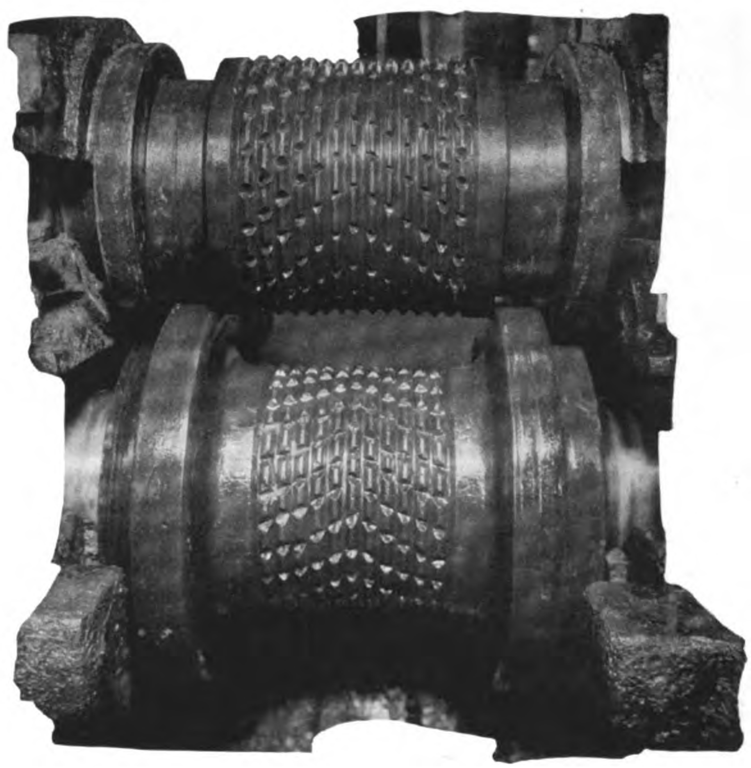
Spellerizing

SPELLERIZING is a process which consists in subjecting the heated bloom (large piece of metal from which "NATIONAL" Pipe is made) to the action of rolls having regularly shaped projections on their working surfaces, then subjecting the bloom while still hot to the action of smooth-faced rolls and repeating the operations, whereby the surface of the metal is worked so as to produce a uniformly dense texture better adapted to resist corrosion, especially in the form of pitting. This process is applicable to the smaller sizes of pipe, four-inch and under, although it is possible in special cases to Spellerize pipe a few inches larger.

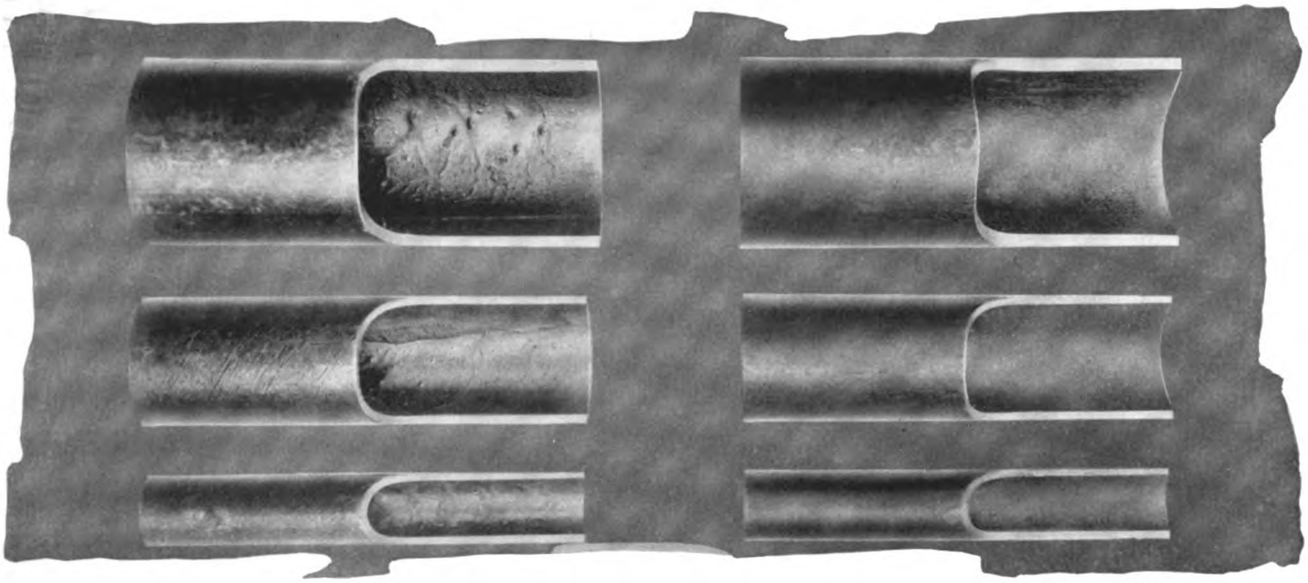
Definition of Process

As a matter of homely fact, the process of Spellerizing metal may be considered analogous to the kneading of dough from which bread is made. Dough is kneaded to produce a smooth, uniform texture; to facilitate the escape of confined gases, which would form air-holes and other irregularities in substance and on surface; and to make an even grain and smooth, fine surface. Much the same results are obtained by Spellerizing the steel bloom. A uniformly dense texture supplementing the natural uniformity in the metal itself of "NATIONAL" Modern Welded Pipe reduces the tendency to galvanic action—which has been found to be the origin of corrosion. As is well known, pipe with any noticeable tendency to pit is eaten through in spots comparatively quickly, thus terminating the effective life of the pipe. In pipe treated by the Spellerizing process there is a marked decrease in the tendency to pit, any corrosion proceeding comparatively slowly and uniformly, the metal of the pipe being, to start with, highly refined and homogeneous.

Spellerizing Metal Analogous to Kneading Dough



Detail view of Spellerizing rolls

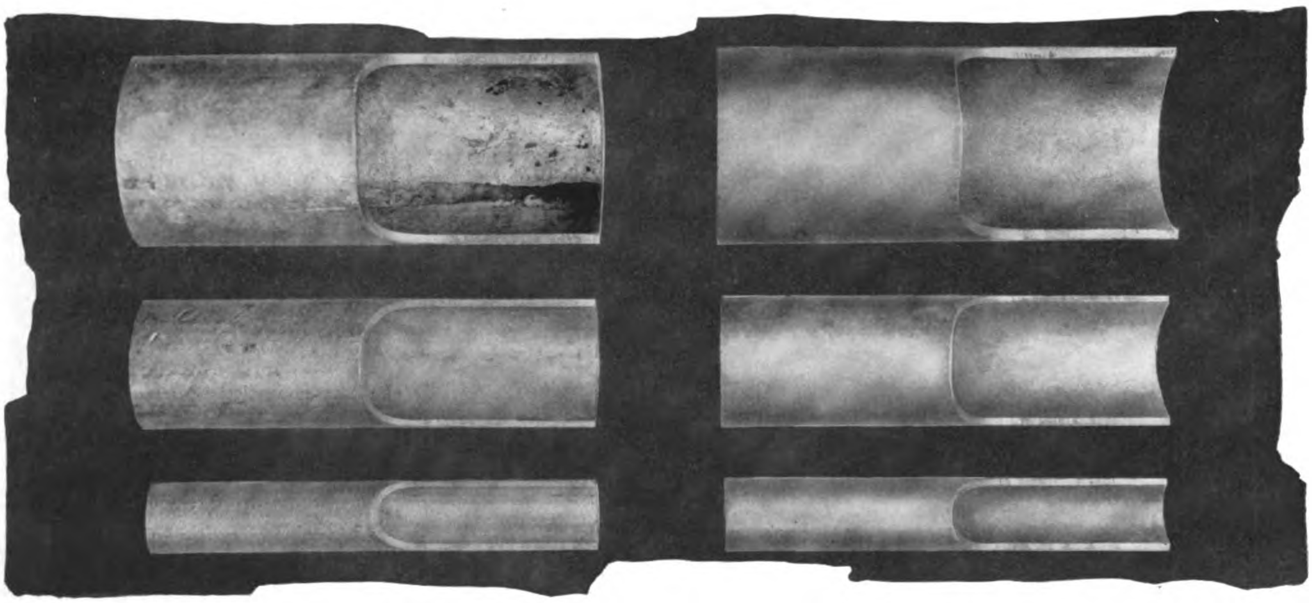


Left View—Standard black butt-weld pipe with characteristic welding-scale

Right View—Standard black butt-weld pipe after being subjected to the scale-free process

Left View—Standard galvanized butt-weld pipe. Galvanizing does not properly adhere to irregular scaly surfaces

Right View—Standard galvanized butt-weld pipe which has been subjected to the scale-free process



Scale-removing Process Applied to "NATIONAL" Pipe

IN addition to the Spellerizing process, "NATIONAL" Butt-weld Pipe (sizes ½ to 3-inch, inclusive) is made by a welding-scale removing process,* which is in a large measure a further application of the Spellerizing process, only in this case the work is applied to the hot-finished pipe instead of to the bloom so that the pipe section is reduced at a forging temperature and the welding-scale broken off. The clean surface of "NATIONAL" Welding-SCALE FREE Pipe reduces still further any tendency to galvanic action.

Scale-removing a Mechanical Process

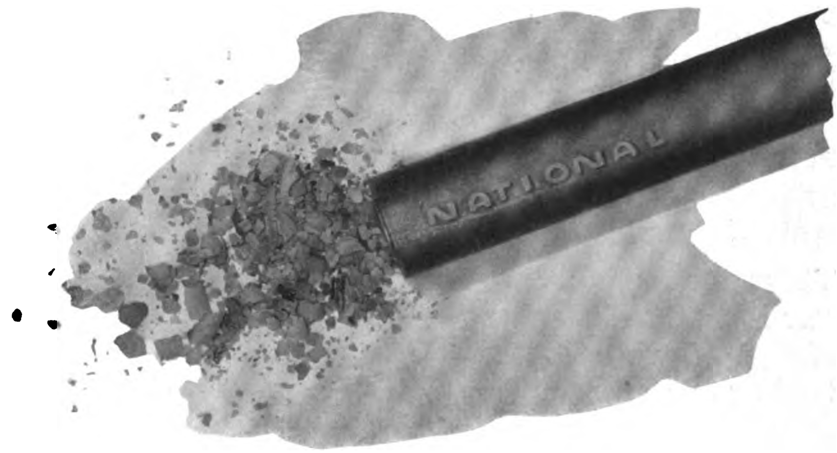
The scale-removing process does not differ substantially from the basic process of making ordinary butt-weld pipe—the result being obtained by the addition of a simple cooling and rolling operation, wherein the welding-scale, which has reached a brittle condition, is cracked loose and later is blown or washed out of the pipe.

When the skelp has reached the proper temperature for welding, it is drawn through the customary type of welding bell (see page 42), forming an unfinished tube. This tube then passes through a set of rolls** where it is reduced slightly in size and elongated (see page 43). In this operation, the welding-scale which has formed is partially loosened by the working of the rolls, but further special treatment is necessary to secure the desired result.

From the sizing rolls the pipe is conveyed to a cooling table across which it travels to the scaling rolls.

It is the nature of welding-scale to harden somewhat more quickly than the pipe metal, and while the pipe is still soft and hot and the scale is in a hardened and brittle condition, the pipe is given a pass through a series of rolls of special design.

*"NATIONAL" Bulletin No. 7—Manufacture and Advantages of "NATIONAL" Welding-SCALE FREE Pipe.
**Ordinarily known as sizing rolls.



Amount of welding-scale removed from a 20-foot length of 3-inch pipe

These rolls reduce the size of the pipe somewhat, as shown in Figs. 11 to 18 inclusive, page 44, crush the pipe down slightly and roll the pipe to its correct finished size. The reduction in size which the pipe receives in passing through the series of rolls cracks the hardened welding-scale from both the interior and the exterior surfaces of the pipe, leaving them clean and smooth.

Removing Welding-scale

From these scaling rolls, the pipe moves to another cooling table where it is kept slowly rolling as it travels across, straightening somewhat as it cools. After a pass through a set of cross rolls, to take care of any straightening that may remain to be done and to give the exterior a smooth, clean finish, the pipe is taken to a tank of water, where it is dipped, lifted to a slanting position and the water allowed to rush out, carrying with it the loose scale from the pipe. (See page 46.) Certain sizes have the loose scale blown out by a blast of compressed air instead of being dipped in the water. This is illustrated on page 47.

The pipe is trimmed, threaded and tested in the usual manner for all butt-weld pipe.

Both the interior and the exterior surfaces of the pipe are rendered smooth and clean by this process. The full interior diameter of the pipe is obtained and an ideal surface is prepared for the uniform and close adherence of galvanizing or other protective coatings; thus the working capacity and the durability of the pipe are appreciably increased.

Results of Scale-free Process

The exterior surface of the pipe is also ideally clean and smooth for the application of enamels, bronzes, paints, platings or other special finishes. This is a highly desirable feature, whether the pipe be used for mechanical constructions, fixtures, etc., or in exposed plumbing installations where it is often necessary to finish the pipe in harmony with the surroundings.

In the past there has been more or less difficulty in securing a satisfactory galvanized interior on pipe—due primarily to welding-scale which is difficult to remove by pickling. Therefore, by the elimination of this scale a more uniform coating of galvanizing is secured. One advantage of this uniformity of galvanizing is apparent when it is remembered that heretofore where welding-scale was present and became loose and dropped off it carried the galvanizing with it and offered an opportunity for any harmful influences to attack this unprotected portion of the metal, frequently resulting in what is known in the trade as "pitting"—the direct result of galvanic action or the concentration of deleterious influences on the few unprotected spots of the metal.

The presence of welding-scale in pipe amounts substantially to a reduction of diameter in that it diminishes the working capacity of the pipe. Maximum efficiency of a pipe is not obtained unless the interior is free from any obstructing causes tending to reduce the flow through the pipe; therefore, by the removal of welding-scale from the inside of the pipe, friction is reduced to the minimum, assuring a maximum flow as originally calculated.

Uniformity of "NATIONAL" Pipe

TO maintain uniformity is one of the chief considerations in the manufacture of tubular products, and the one way to obtain this end is to control each succeeding process from ore to finished pipe.

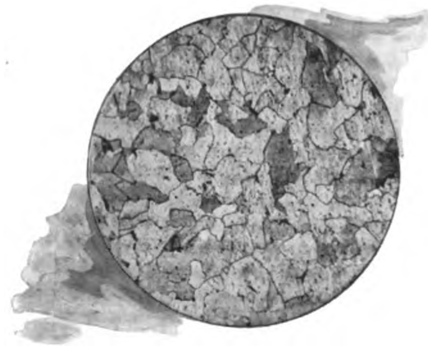
Uniformity Maintained by Control of All Processes

Therefore, the first step in the control of the uniformity of chemical and physical properties of "NATIONAL" Pipe begins in the selection of the iron ore. Only that grade of ore is used which measures up to the rigid standards of chemical analysis set by National Tube Company. From the time the high grade ore is charged into the blast furnace until the resultant metal emerges from the mill in the form of finished pipe, each successive operation is supervised by a corps of technical and mechanical experts.

The use of high grade raw materials, smelting and refining the metal in larger unit quantities by modern mechanical methods, and an intensive system of inspecting and testing are some of the factors which control the continuous uniformity of "NATIONAL" Pipe.

Continuous uniformity in wrought pipe means smaller scrap losses, better welding and threading qualities, and longer life under corrosive conditions; hence, it is of benefit to manufacturer and consumer alike.

Microphotograph showing uniform structure of pipe steel



Physical Properties of "NATIONAL" Pipe

"NATIONAL" Pipe steel is intrinsically strong and ductile. Its elongation in 8 inches varies from 18 to 24 per cent; elastic limit will average about 36,000 pounds per square inch, while the tensile strength, taken in either direction to rolling, is about 58,000 pounds per square inch. These desirable physical properties result from the use of high grade raw materials, and from following the most approved methods of manufacture, under the control of one organization —supervised by technical and mechanical experts.

MATERIAL	Average Chemical Analysis				Average Physical Tests			
	Carbon	Manganese	Sulphur	Phosphorus	Elastic Limit	Tensile Strength	Elongation in 8 Inches	Reduction in Area
	%	%	%	%	Pounds	Pounds	%	%
Bessemer Pipe Steel	.07	.30	.045	.100	36,000	58,000	22	55
Open Hearth Pipe Steel	.09	.40	.035	.025	33,000	53,000	25	60

Some Interesting Tests to Determine Physical Properties

"NATIONAL" Pipe possesses high bursting strength because the material from which it is made is homogeneous and contains no lines of weakness due to presence of cinder or other foreign matter. Some interesting tests have been conducted on the bursting strength of tubes and pipe. The results of these tests are covered in a paper, "Strength of Steel Tubes, Pipes and Cylinders Under Internal Fluid Pressure", by Professor Reid T. Stewart, University of Pittsburgh, which was read before the American Society of Mechanical Engineers and incorporated in Volume 34 of the Society's Proceedings. Another series of twisting tests was made by Mr. T. N. Thompson on ½, ¾ and 1-inch butt-weld pipe, and the results are incorporated in a paper read before the American Society of Heating and Ventilating Engineers.

An unusual physical test

Ductility of "NATIONAL" Pipe

DUCTILITY is an essential quality in pipe that is to be used for bending, flanging, expanding, coil-forming and similar purposes. "NATIONAL" Modern Welded Pipe has this desirable quality in a high degree and is therefore manipulated with comparative ease, whether the work consists of making a large expansion loop, expanding or rolling the end of a pipe into a flange, or forming an offset or cross-over. This quality of ductility is supplemented by strength which successfully resists shocks, vibrations and abuse that would probably shatter or weaken ordinary pipe, and for this reason alone "NATIONAL" Pipe is used in many places where heretofore other types of construction were used; cross-overs, offsets, etc., formerly made of short pieces of pipe and fittings, are representative examples.

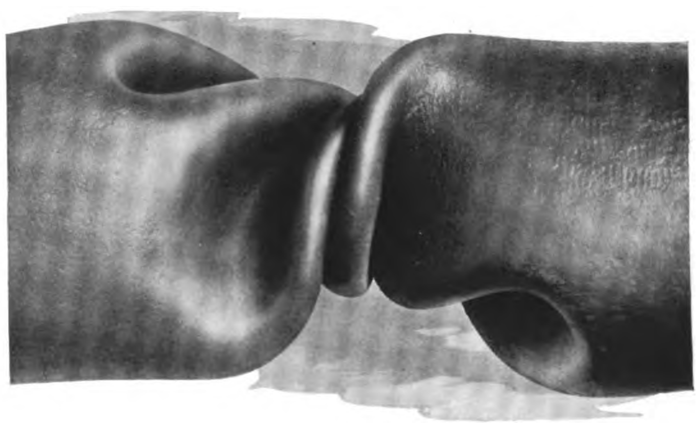
Ductility an Essential Quality in Modern Wrought Pipe

The many small, though important, concessions to which piping systems must conform in certain installations for reason of space economy, operating efficiency and appearances, call for designs and layouts in which the ductility of "NATIONAL" Pipe has frequently proved of great assistance.

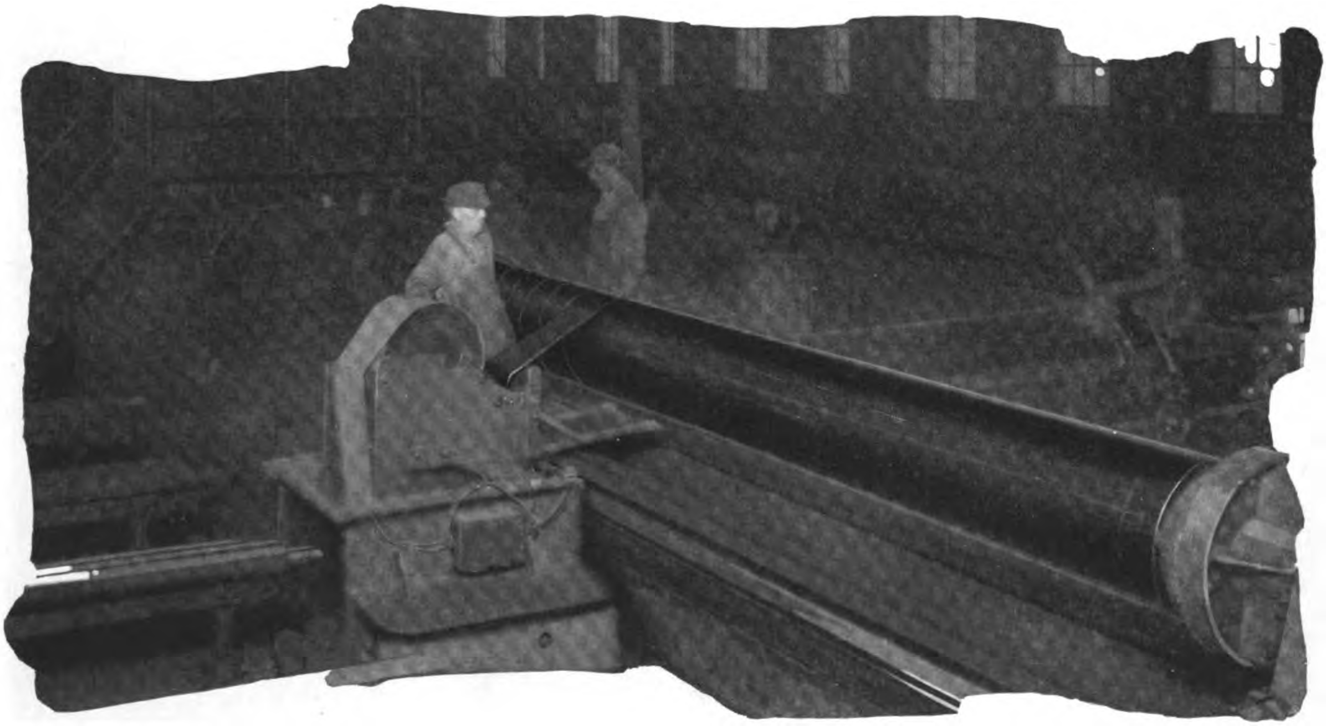
Ample ductility combined with high tensile strength is in many instances a much desired quality in wrought pipe. These combined qualities are well illustrated below; this piece of 8-inch "NATIONAL" Line Pipe resisted without fracture a twisting force of 713,000 inch-pounds, making it look like a piece of rubber. The enormous twisting force can be appreciated when it is remembered that the pipe wall is about 5/16 inch thick and weighs in the neighborhood of 28 pounds per foot. This example demonstrates the ability of the material to meet abnormal conditions, or to stand up under severe punishment and manipulation, although there are few if any uses for wrought pipe where the material would be subjected to as great a twisting force as that which was applied in this particular instance. The test is, nevertheless, significant.

Unusual Strength and Ductility

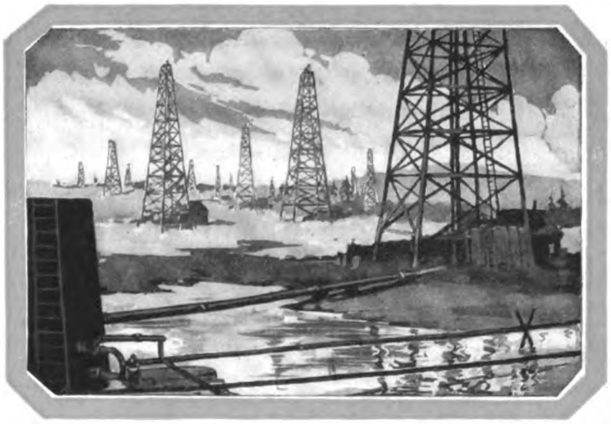
8-inch line pipe subjected to a twisting force of 713,000 inch-pounds



Removing galvanized pipe from bath of molten zinc



Applying saturated fabric to dipped pipe for protective coating



Uses of "NATIONAL" Modern Welded Pipe

WHEN one considers that the introduction of wrought pipe dates back less than one hundred years; that the use was then confined almost entirely to gas and water lines; that today the varied uses and applications can scarcely be enumerated—it must be acknowledged that modern wrought pipe has been and is an important economic factor in the progress of our domestic, industrial, civic and national life.

The importance of wrought pipe will be more clearly appreciated if we compare the highly developed water supply systems or the light of the modern gas burner and electric lamp of today with the village pump and the tallow dip of yesterday.

Economic Importance of Wrought Pipe

Today, wrought pipe brings to our cities an unlimited supply of pure water, and natural gas from wells often located hundreds of miles away; without it, our ice supply would be dependent upon natural sources, and it would be practically impossible to heat our office buildings, hotels, apartments, schools, industrial plants and hundreds of other public and private institutions. Modern welded pipe conveys throughout such buildings the enormous quantities of water necessary for sanitary and drainage purposes, transmits power to run dynamos, elevators, pumps, etc., and furnishes protection against fire, in the form of high pressure water lines and automatic sprinkler systems.

Modern welded pipe is necessary for the construction of interlocking signal systems on our railroads, and for the successful operation of the air brake equipment on trains. Modern welded pipe and tubes are necessary for a high standard of locomotive efficiency and to add to the comforts and conveniences in the passenger cars.

Modern welded pipe is used extensively in greenhouses for heating and irrigating purposes, and for the irrigation of gardens and farms.

The lumber used in the construction of your home and of your furniture was in many cases cured or dried in kilns heated by coils made of modern welded pipe.

The comfortable enameled beds, the operating tables and apparatus, the tables, desks, chairs, cots, stretchers and other indispensable furnishings of the modern hospital are made from modern welded pipe. The nickeled piping on your kitchen range also is of wrought pipe.

Uses of Wrought Pipe Practically Unlimited

The agricultural machinery of the modern farm has been made stronger, lighter and more durable by the use of modern welded pipe in place of the heavier and more cumbersome wooden or solid metal parts used in the older types of machines. Important parts of hundreds of large and small machines of every description are made of wrought pipe. Water, gas and oil wells are drilled and cased with it.

The apparatus of our municipal playgrounds and gymnasiums, the railings surrounding the dangerous places in our factories, buildings, parks and schools, fire escapes and ladders are made of wrought pipe in innumerable instances. Underneath the highly polished or artistic lighting fixtures of your home, club, apartment or hotel, public buildings or schools, you will find modern welded pipe used for conduit or as a structural basis.

If, perchance, you have a baby carriage, you will probably find that part of the framework and the handles are made of wrought pipe.

And so, on and on runs the almost unending list of uses of modern welded pipe. To list every individual use would be an impossible task, but the following applications will give the reader a vision of the scope of usefulness of the material:

Accessories for Air and Electric Drills
Acid Piping
Agricultural Implements
Air Brake Pipes, Compressors, Inter-coolers
" Conductors
" Distributing Apparatus
" Drills
" Drums
" Lines
" Pumps
" Shafts
Ammonia Coils
" Cylinders, Anhydrous
" Lines
Anhydrous Ammonia Cylinders
Animal Cages
Apparatus, Air-distributing
" Dry Kiln
Apparatus, Gymnasium
" Ice Making
" Play Grounds
" Steam Gauge Testing
Arc Light Supports
Arch Pipes
Ash Conveyors
Automobile Exhaust Pipes
" Gear Shifts
" Manufacture of
Awning Brackets
" Frames
" Pipe, Manufacture of
Axles, for Newspaper Rolls

Baby Carriages
Baker-Heater Pipes
Balcony Railings
Barrels, Blasting
Beams, Brake
Bedsteads, Frames for
" Manufacture of
Beet Toppers
Bell Cord Protecting Pipe
Bends, Steam
Bicycles, Manufacture of
Blast Furnace Bustle Pipes
Blasting Barrels
Blower Pipe
Blowing Engines
Boiler Tubes
Bolts, Foundation
Box Coils
Braces, for Structural Work
Bracket, Awnings
" Coils
Brake Beams
Bridge Pipe, Locomotive
Building Columns
" Construction
Bushings

Cages, Animal
Candelabra
Carriages, Baby
Cars, Elevator
Casing, Dog Guard
" for Elevator Plungers
Catchers, Cow
Cement Conveyors
Chain Supports for Subway Cars
Chairs, Invalid
Chandeliers, Electric
" Gas
Chemical Conveyors
Chutes for Scrap Metal
Clay Transmission Lines
Clothes Reels
Coils, Ammonia
" Box
" Bracket
" Condenser
" Conductor
" Heater
" Heating, for Mine Service
Columns for Buildings
" Pump
Condenser Coils
" Tubes for Sugar Refineries
" Tubes for Various Purposes
Conductor, Air
Conduit, Electrical
" Insulation
Connecting Rods
Construction, Building
Conveyors, Cement
" Chemical
" Ash
Coolers, Ice
Cooling Systems, Gas Engine
Cores
Cots
Cow Catchers
Cups, Thermometer
Cyanide Process for Refining Metals
Cylinders, for Anhydrous Ammonia
Cylinders, for Elevator Plungers
" Loom
" Oil Well
" Oxygen
" Pneumatic Tools

Dead Rollers
Die Stock Handles
Diggers, Post Hole
" Potato
Discharging Pipe for Condensers on Steam Lines
Distance Pieces in Mine Railwork
Dollies, Timber
Drain Pipes
Drainage Lines
Dredge Discharge Lines
Drill Pipe
" Rods
Drills, Air
Drilled Wells
Drinking Water Systems
Drive Pipe
" Well Points
Driven Wells
Dry Kiln Apparatus
Dry Pipes

Electric Conduit
" Dynamo Supports
" Heaters
" Light Supports
" Line Poles
" Motor Frames
" Sign Supports
" Signal "
" Truck Frames and Air Drill Accessories
Elevator Cars and Grill Work
" Casing for Plungers
" Grain Spouts
" Plungers
Engine Supports in Automobiles
Exhaust Pipes
Expansion "

Farming Implements
Feed Pipe, Intercooling
Feed Line in Gas Stoves
Fence Posts
Fences, Ornamental
" Tennis Court
Fire Escape Work
Fishing Rods
Fixtures, Store
Flag Poles
Flush Tubing
Foot Rails
Foundation Bolts
Frames, Agricultural
" Awning
" Bed Stead
" Electric Sign
" Go-cart
" Gymnasium
" Machinery
" Mattress
" Play Ground
" Tent
" Truck
" Wheel Barrow
" Work Bench

Gas Chandeliers
" Conductors
" Engine Cooling Systems
" Fixtures
" Lines
" Stoves
" " Feed Lines
" " Railing
Gasoline Lines
Gates, Ornamental
Grain Spouts, in Elevators
Grape Vine Trellis
Grill and Elevator Work
Grip Pipe
Guards, Window
Gymnasium Apparatus

Hammers, Steam
Hand Rails
Handles, Die Stock
" Lever
" Shovel
Hawser, Pipe for Boats

Headers
Heater Coils
Heaters, Electric
" Instantaneous
Heating Systems
" Coils for Mine Service
Heavy Railing
Hitching Posts
Hollow Shafts
Hospital Furniture
Hot Air Furnaces
Hydraulic Discharge Pipe
" Ram Casing
" Transmission Lines
Hydro-electric Power Transmission Lines

Ice Making Apparatus
" Coolers
Implements, Farming
Instantaneous Heaters
Inter-coolers, Air Compressors
Invalid Chairs
Irrigation Systems

Jacks, Manufacture of
Jail Windows and Doors

Kiln, Dry, Apparatus

Ladder Rungs
Ladders
Lamp Brackets
" Posts
Lathes, Manufacture of
Lever Rods for Jump Saws
" Handles
Line Pipe
Lines, Air
" Ammonia
" Clay Transmission
" Discharge
" Drainage
" Dredge
" Hydraulic Transmission
" Phosphate Rock "
" Sewerage
" Steam
" Water

Lines, Water for Sprinkling in Dusty Mines
Live Rollers in Lumber Mills
Locomotive Bridge Pipes
" Sand "
Loom Cylinders
Lunch Counter Stools

Machinery Frames
Mandrels
Manufacture of Automobiles
" " Bedsteads
" " Bicycles
" " Motorcycles
Masts, Warship
Mattress Frames
Mines, Pneumatic Signals for
Motor Boat Exhaust Pipes
" Cycles, Manufacture of

Newspaper Axle Rolls
Novelties
Nipples

Office Railings
Oil Lines
" Well Casing
" " Cylinders
" " Drive Pipe
" " Rotary Drive Pipe
" " Tubing
Ornamental Fixtures
Ornamental Work for Light Poles

Paint Lines
Paper Core
Partitions
Phosphate Rock Transmission Lines
Piano Movers' Rollers
Piling for Piers and Docks
Pillars
Pipe, Acid
" Air Brake
" Arch
" Baker-Heater
" Blast Furnace Bustle
" Blower
" Drain
" Drill

Pipe, Dry
" Exhaust
" Expansion
" Locomotive Bridge
" Motor Boat Exhaust
" Protection for Bell Cords
" Racks
" Stands
Piston Rods, of Shot Gun on Lumber Carriages
Play Ground Apparatus
Plumbing Systems
Plungers, Casing
" Elevator
Pneumatic Signal System for Mines
Pneumatic Tool Cylinders
Points, Drive Well
Poles, Electric Lighting
" Flag
" Power Transmission
" Railway Signal
" Telegraph
" Telephone
" Traction
" Transmission
" Wireless Telegraph
Post Hole Diggers
Posts, Fence
" Sign
Potato Diggers
Power Plants
Printing Press Rollers
Protecting Pipes for Bell Cords
" Tubes for Pyrometers
Pump Columns
" Handles
" Plungers
" Set
Pumps, Air
Pyrometer Protecting Tubes

Racks, Display, for Clothing, etc.
Radiators
Railroad Tell Tables
Railings for Balconies
" Office

Rails, Foot
" Hand
" on Gas Stoves
Railway Signal Poles
" " Rods
Ram Casing, Hydraulic
Reels, Clothes
Refineries
Refining, Cyanide Process
Refrigerating Systems
Retorts
Rocker Frames for Rocker Lumber Saws
Rods, Connecting
" Drill
" Fishing
" Lever
" Railway Signal
" Sucker
Rollers, Dead
" Heavy-weight
" Moving
" Piano Movers'
Rolls, Newspaper Axle
Rose Trellis
Rotary Pipe
Rotary Drive Pipe
Rungs, Ladder
Runners for Sleighs

Safe Ends
Sand Pipes for Locomotives
Scrap Metal Chutes
Sewerage Lines
Shafting
Shafts, Hollow
" Pulley
Shovel Handles
Sign Posts
Signal Apparatus
" Interlocking
" Pneumatic, for Mines
" Poles
" Rods
" Towers
Signals, Railroad
Signs, Electric, Supports for
" Posts
Size Rings (for Driving Down Wood Piling)
Sleeves
Socket Wrenches
Speaking Tubes
Spokes for Wheels
Spouts, Grain, in Elevators
Sprinkler Systems
" " for Dusty Mines
Stanchions
Stand Pipes
Steam Bends
" Conductors
" Feed Valves
" Gauge Testing Apparatus
" Hammers
" Lines
Stools for Lunch Counters
Store Fixtures
Stoves, Manufacture of
Strainers
Structural Work Braces
Sucker Rods
Superheater Calorimeter Parts
Supporting Rods for Water Meter
Supports for Chimneys
" " Dynamos
" " Electric Signs
" " Tables
Systems, Drinking Water
" Fire Protection
" Gas Engine Cooling
" Heating
" Irrigation
" Plumbing
" Pneumatic Signal, for Mines
" Refrigerating
" Sewerage
" Signal
" Sprinkler
" Vacuum
" Water

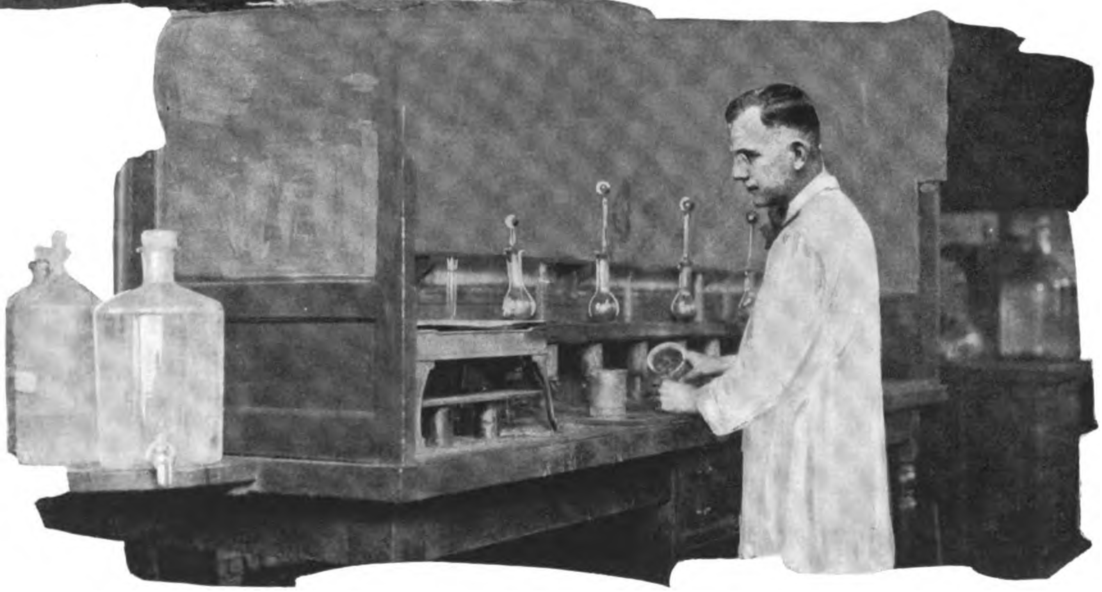
Table Supports
Tanks
Telegraph Poles
Telephone "
Turn Tables, Railroad
Tennis Court Fences
Tent Frames
Thermometer Cups
Timber Dollies
Tools, Pneumatic Cylinders for
Toppers, Beet
Towers, Signal
" Transmission Line
" Windmill
Transmission Lines, Clay
" " Electric
" " Hydraulic
" " Power
" " Towers
Trellises
Trolley Poles
Trucks, Frames for Electric
Trunks, Manufacture of
Tubes, Boiler
" Condenser
" Pyrometer Protecting
" Speaking
Tubing, Flush
Tubular Poles
Turnstiles
Tuyere Pipes

Vacuum Systems

Warship Masts
Water Conductors
" Drinking Systems
" Lines
" Meter Supporting Rods
Well Points, Drive
Wells, Drilled
" Driven
Wheel Barrow Frames
" " Handles
" Spokes
Windmill Towers
Window Guards
Wireless Telegraph Apparatus
" " Poles
" " Towers
Wrenches, Socket

View in chemical laboratory where materials for pipe are analyzed

Photomicroscope, frequently used to determine structure and character of metals



Analyses of materials under way in chemical laboratory

Technical Research

FROM the earliest dawn of history, the achievements in the arts and sciences, in mechanics and industries, in discovery and invention, have been accomplished by the thinkers of the world, through research.

Limitations of Early Research

Throughout past centuries the purposes of research, particularly in chemistry, were almost entirely confined to the discovering of something new. To the modern chemist the world owes in large measure the notable commercial results of modern industrial research—for his purpose is that of eradicating the old obstructing causes as well as that of evolving new effects.

Important work along this line was instituted on a large scale by National Tube Company, and was in consonance with their original ideals to be ever in advance of present conditions—ever striving to improve both methods and materials.

Scope of Modern Research

To discover causes of failure and to ameliorate effects of corrosion; to investigate unusual conditions of service; to study methods of manufacture, installation and operation; to develop new processes—these and similar problems were given to a department composed of technical, metallurgical and chemical experts. This research department was established to collect, compile and tabulate data and general information about pipe in all sorts of service, under all sorts of conditions, and with this particular aim: to improve and make more suitable for the service intended, wherever and however possible, all "NATIONAL" modern welded tubular products. A large commission!

The Department of Research of National Tube Company was instituted primarily to improve the material and service of "NATIONAL" products, yet the entire steel tubular industry—and consequently nearly the entire pipe consuming trade—has benefited, as witness the fact that over ninety per cent of the wrought pipe used today is steel.

The vast accumulation of valuable information compiled by this department has been rendered available to all who are interested in pipe, by publication in "NATIONAL" Bulletins. These Bulletins cover various fields in which pipe is used, and while each Bulletin differs in scope, all have one aim—the presentation, to manufacturers and consumers, of certain definite facts, data, results of special tests, methods of use, engineering tables, etc., etc.; in short, the cream of National Tube Company research for the benefit of the tubular interests at large.

Valuable Research Available to All Users of Pipe

"NATIONAL" Bulletins are furnished free of all charge to those whose letterheads or business activities would indicate a legitimate use. While in some special cases a complete file for reference may be desirable, those Bulletins alone which treat of certain allied subjects are sufficient for the average reader's technical library.

For example: One who is interested in "NATIONAL" Bedstead Tubing would scarcely be interested in "NATIONAL" Pipe for Refrigerating Systems, or in those Bulletins devoted to the subject of corrosion.

The list of titles of "NATIONAL" Bulletins following will be found sufficiently comprehensive to enable one to decide without difficulty which Bulletin or Bulletins are required for his purpose. It is only necessary to ask the nearest District Sales Office for what is required, to receive one's choice.

"NATIONAL" Bulletins

"NATIONAL" BULLETIN NO. 1—*Some Recent Developments in Testing Boiler Tubes.*
"NATIONAL" BULLETIN NO. 2—*Corrosion of Hot Water Piping.*
"NATIONAL" BULLETIN NO. 3—*The Prevention of Corrosion in Pipe.*
"NATIONAL" BULLETIN NO. 4—*Corrosion of Boiler Tubes.*
"NATIONAL" BULLETIN NO. 5—*"NATIONAL" Pipe for Refrigerating Systems.*
"NATIONAL" BULLETIN NO. 6—*Correct Pipe Threading Principles.*
"NATIONAL" BULLETIN NO. 7—*Manufacture and Advantages of "NATIONAL" Welding-SCALE FREE Pipe.*
"NATIONAL" BULLETIN NO. 8—*"NATIONAL" Coating.*
"NATIONAL" BULLETIN NO. 9—*"NATIONAL" Pipe for Shipbuilding Purposes.*
"NATIONAL" BULLETIN NO. 10—*Relative Corrosion of Iron and Steel Pipe as Found in Service.*
"NATIONAL" BULLETIN NO. 11—*History, Characteristics and The Advantages of "NATIONAL" Pipe.*
"NATIONAL" BULLETIN NO. 12—*Characteristics of "NATIONAL" Pipe.*
"NATIONAL" BULLETIN NO. 14—*"NATIONAL" Tubular Steel Poles.*
"NATIONAL" BULLETIN NO. 15—*"NATIONAL" Pipe for Drilling Purposes.*
"NATIONAL" BULLETIN NO. 16—*"NATIONAL" Stationary and Marine Boiler Tubes.*
"NATIONAL" BULLETIN NO. 17—*The Manufacture and Use of "SHELBY" Seamless Steel Tubing.*
"NATIONAL" BULLETIN NO. 18—*"NATIONAL" Reamed and Drifted Pipe.*
"NATIONAL" BULLETIN NO. 19—*List of Products.*
"NATIONAL" BULLETIN NO. 20—*Index of "NATIONAL" Bulletins 1 to 20.*

"NATIONAL" BULLETIN No. 21—*"NATIONAL" Tubing for Bedsteads, Metal Furniture, etc.*
"NATIONAL" BULLETIN No. 22—*"NATIONAL" Pipe for Railway Signal Service.*
"NATIONAL" BULLETIN No. 23—*"NATIONAL" Dry Kiln Pipe.*
"NATIONAL" BULLETIN No. 24—*The Rise of Steel Pipe.*
"NATIONAL" BULLETIN No. 25—*"NATIONAL" Pipe in Large Buildings.*
"NATIONAL" BULLETIN No. 26—*Autogenous Welding of "NATIONAL" Pipe.*
"NATIONAL" BULLETIN No. 27—*Uses of "NATIONAL" Pipe.*

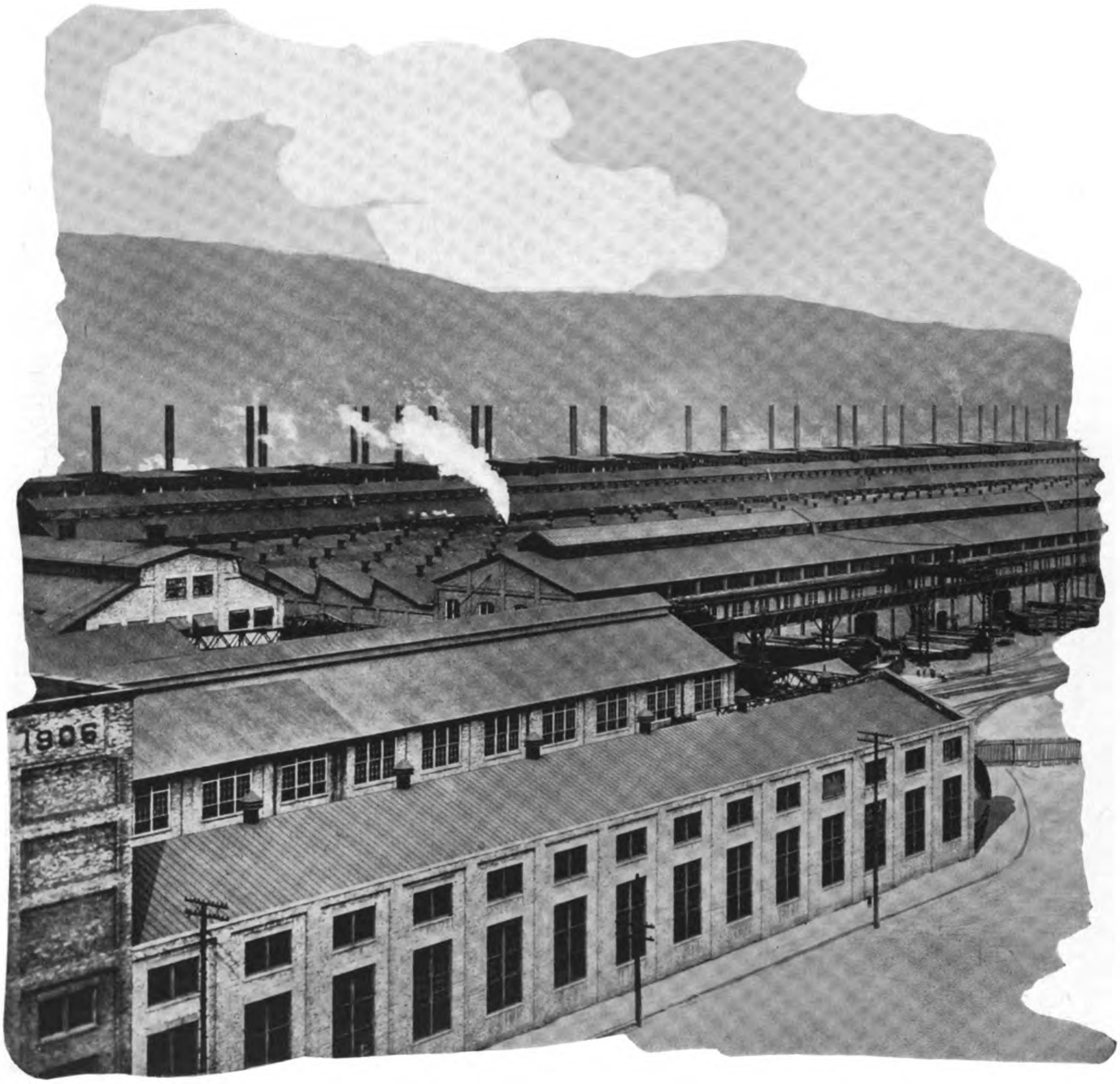
Books and Other National Tube Company Literature

In addition to these Bulletins, National Tube Company issues a number of booklets and other publications devoted to the subjects of wrought pipe, tubing and allied tubular products. These publications, like the Bulletins, treat of individual subjects, with the exception of the book of "NATIONAL" Pipe Standards (which is an engineer's hand-book and of more general usefulness). For example, there is a 72-page illustrated booklet devoted to the manufacture and advantages of "NATIONAL" Matheson Joint Pipe; another detailing the manufacture of "SHELBY" Seamless Steel Tubing; a 95-page book by a noted authority, on the subject of Collapsing Pressures of Lap-welded Steel Tubes; and numerous booklets and pamphlets covering such subjects as Boiler Tubes, Trolley Poles and Mechanical Tubing.

Copies of any or all of these publications may be had, free of any charge, with the single exception of the book of "NATIONAL" Pipe Standards, from any District Sales Office of National Tube Company.

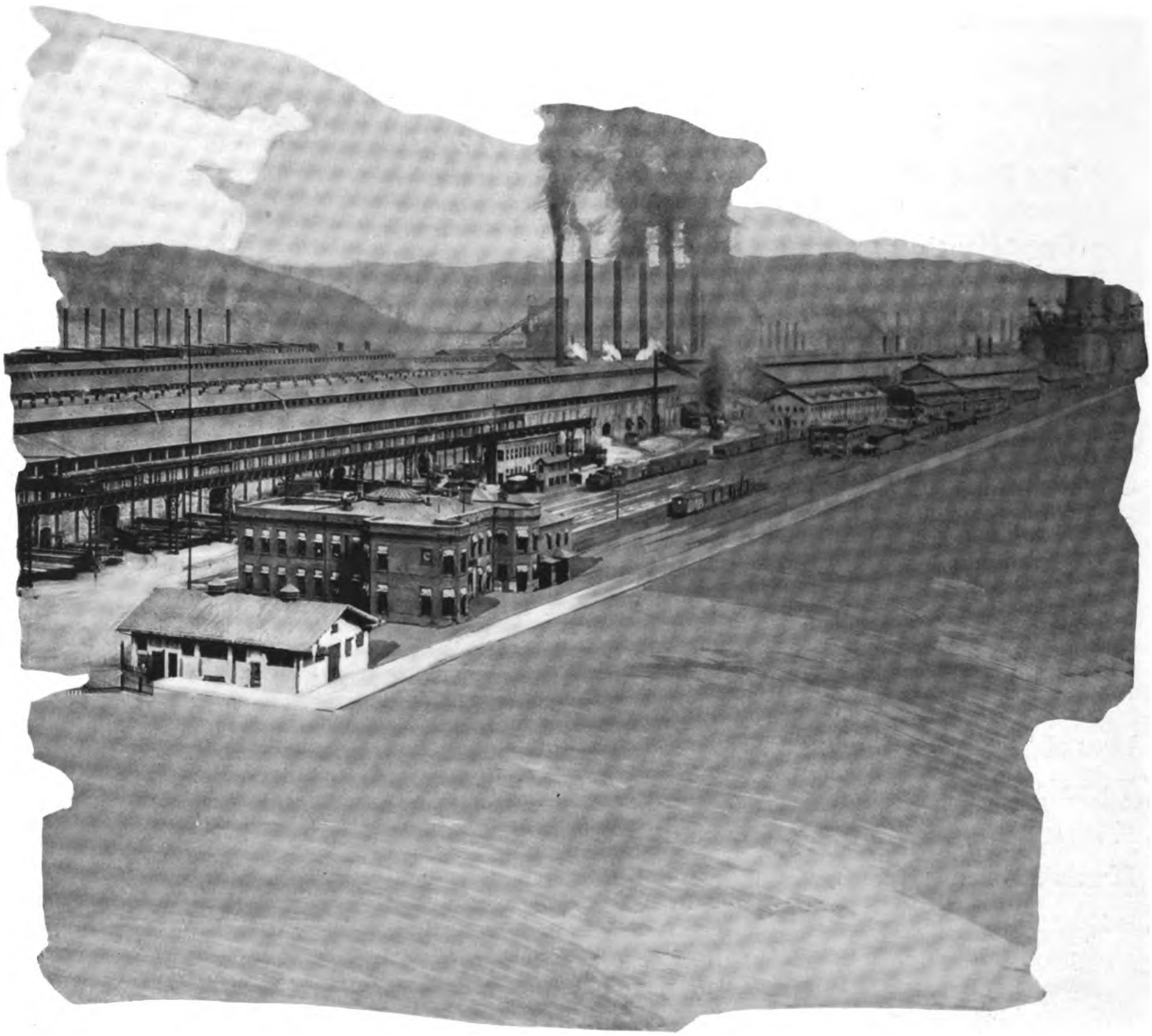
National Tube Company's NATIONA

THE NATIONAL WORKS OF NATIONAL TUBE COMPANY is situated on the Monongahela River at McKeesport, Pennsylvania. These works are a little over a mile in length and cover about 100 acres. The main tube and pipe mill of this plant is nearly 1,600 feet long and 600 feet wide, containing in all approximately 23 acres, and is believed to be the largest building of its



L Works, McKeesport, Pennsylvania

kind under one continuous roof in the world. In addition to the McKeesport plant, mills of National Tube Company are located at Christy Park, Pa., Ellwood City, Pa., Lorain, O., Pittsburgh, Pa., Syracuse, N. Y., Wheeling, W. Va., and Versailles, Pa.; there being eleven in all, devoted exclusively to the manufacture of wrought tubular products.



“National” Modern Welded Pipe

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